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INSTRUCTION MANUAL
DIGITAL I/O SYSTEM OPTION
SD345
SPECTRASCOPE III

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Spectral Dynamics
Scientific-Atlanta

SERIAL 322

INSTRUCTION MANUAL

DIGITAL I/O SYSTEM OPTION

SD345 SPECTRASCOPE III

SD345-OPTION-3A01

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

This manual describes the operation of the Digital I/O System Option for the Spectral Dynamics Model SD345 Spectrascope® III. The manual contains installation, operational set up, interface control signals, data transfer conventions and data formats. No maintenance information is included in the manual. Theory of operation and maintenance information is contained in the SD345 Service Manual.

1.2 EQUIPMENT DESCRIPTION

The Digital I/O System Option circuitry is contained on PWA 21185900 located in card position A5A16. The SD345 Digital I/O System Option comes in seven different configurations. These are as follows: -3, -3A00, -3B00, -3A01, -3B01, -3A02 and -3B02. This manual contains information that covers all of these configurations. Table 1-1 defines what is included with each Option configuration.

Table 1-1. I/O Option Configurations

Index	Item	-3	-3A00	-3B00	-3A01	-3B01	-3A02	-3B02
1	IEEE Interface	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	RS-232-C Interface	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Format	HP2100MX	HP2100MX plus SDC	DEC plus SDC	HP2100MX plus SDC	DEC plus SDC	HP2100MX plus SDC	DEC plus SDC
4	Time Domain Signal	Out Only	In/Out	In/Out	In/Out	In/Out	In/Out	In/Out
5	ID Block	No	Yes	Yes	Yes	Yes	Yes	Yes
6	SD Format High Speed	No	Yes	Yes	Yes	Yes	Yes	Yes
7	Modify Alphanumerics on Crt	No	Yes	Yes	Yes	Yes	Yes	Yes
8	Digital Plotter Interface	HP Series Via HP9825A Calculator[1]	HP Series Via HP9825A Calculator[1]	HP Series Via HP9825A Calculator[1]	HP Series Direct[1]	HP Series Direct[1]	TEK 4662 Direct[2]	TEK 4662 Direct[2]
9	Secondary Addresses 6, 9, 14, 16, 18	No	Yes	Yes	Yes	Yes	Yes	Yes

[1]HP7225A (IEEE or RS-232-C); HP7220 (RS-232-C only); HP9872B (IEEE only); HP9872A (IEEE with an external controller).

[2]IEEE only.

1.3 SPECIFICATIONS

Signals from External Device	Should conform to IEEE STD-488-1975-78 Section 3.3. Standard open collector TTL levels with a power source $>+$ 4.75V and $<+$ 5.25V referenced to logic ground.
Logic Levels	"0" $<+$ 0.4V, "1" $\geq+$ 2.4V
End or Identify (EOI)	Negative True
Remote Enable (REN)	Negative True
Interface Clear (IFC)	Negative True
Attention (ATN)	Negative True
Not Data Accepted (NDAC)	Positive True
Not Ready for Data (NRFD)	Positive True
Data Available (DAV)	Negative True
Data Input/Output (DIO) (8 lines)	Positive True
Signals to External Device	Conform to IEEE STD-488-1975-78 Section 3.3. Standard open collector TTL levels. Power source $>+$ 4.75V and $<+$ 5.25V referenced to logic ground.
Logic Levels	"0" $<+$ 0.4V, "1" $\geq+$ 2.4V
End or Identify (EOI)	Negative True
Service Request (SRQ)	Negative True
Not Data Accepted (NDAC)	Positive True
Not Ready for Data (NRFD)	Positive True
Data Available (DAV)	Negative True
Data Input/Output (DIO) (8 lines)	Positive True

1.4 REPLACEMENT PARTS

Except for some special SDC specification controlled parts listed, standard electronic parts are used in the I/O Option circuitry. To aid in replacement, some miscellaneous parts are also listed. For other parts also used in the SD345 refer to the parts list in the SD345 User's Manual. Spectral Dynamics maintains a stock of parts used in this option.

When ordering parts, include assembly number of card reference designation, description, and SDC part number. Also include the instrument serial number and complete model number including "dash" number.

Reference Designator	Description	Part Number
A16U13, 15, 16, 35	IC, Bus (GPIB) Transceiver Motorola Part No. MC3448A	10717600
A16U14	IC, GPIB Talker/Listener Intel Part No. 8291	10729000
A16U65, 66	IC, PROM Set	21100700
A16U39	IC, Asynchronous Communications Element, National Part No. INS8250N	10732300

SECTION II

INSTALLATION

2.1 INTRODUCTION

This section contains instructions for performing initial inspection of the Model SD345 Digital I/O System Option. Procedures for inspecting, checking for physical damage, reshipment and returning under warranty or damage claims are in the SD345 User's Manual.

2.2 PREPARATION FOR USE

2.2.1 Option Included with Initial Instrument

If the Digital I/O System Option is included with the SD345, this subsection does not apply, continue to Section III.

2.2.2 Option Field Installation

When the option is to be installed in the field, the following procedure should be used:

a. Insure that the SD345 is operating properly.

b. Remove power from the SD345.

c. Unplug the instrument.

d. Remove the top cover.

e. Insure that all plug-in ICs are firmly seated and that component parts mounted on the option card do not protrude enough to cause damage when the card is inserted.

f. Carefully insert the option card in the slot marked A16.

g. Make sure that the card is fully seated and the top of the card is even with the other cards.

h. Plug in the AC power cord.

i. Replace the top cover.

j. Turn on the SD345.

SECTION III

OPERATION

3.1 INTRODUCTION

This section contains detailed information to set up rear-panel switches, I/O card switches, interface control sequences, data transfer conventions, and listings of formats for each type of data transmitted and received.

As explained in the SD345 User's Manual, the SD345 has, as standard features, the capabilities to average FFT ensembles into storage memory, transfer to a second storage memory, display in lin or log distribution on either the amplitude or frequency axis, measure levels in user entered "Engineering Units," capture transient signals and hold them for analysis, expand the display around any frequency within its range, store a front panel configuration for later use, and many other useful features, all of which together make it a highly flexible instrument.

This flexibility, and the versatility of the SD345, makes it necessary to provide an I/O structure that provides access to as much of the capabilities of the SD345 as possible. For this reason, and for information purposes, it wil be necessary to divide the following discussion on the I/O Option into three major areas. These are:

a. Data out of the SD345.

b. Data/control accepted by the SD345.

c. Interfacing with the SD345 I/O.

3.1.1 Data Out of the SD345

All numerical processing within the SD345 is handled by a 3000 Microprocessor, with the memories being available to a Z80 Microprocessor (this is the Microprocessor in the SD345 that handles interface between the front panel, crt and the 3000 Microprocessor) at different stages. The I/O Option is also controlled by the Z80. Anything that the Z80 has access to can be delivered to the I/O Option. The memories that are available to the Z80 are, primarily, the input signal in digitized form, the FFT of the input signal, and the memory array transmitted to the crt (less accurate in resolution than the FFT, but resolved with LOG X, LOG Y, dB, EU, Hz versus KCPM and other manipulations which change the display of the same FFT).

The three sets of numerical data referred to in the previous paragraph are defined as Time Mode (input signal), Spectrum (FFT) and Trace (display array).

The configuration of the front panel, including all switch settings, the value for either TH%, dB REF or MV/EU (dependent upon which is in use), frequency range, input level, function selected and the number of averages taken is available in a 32 byte string defined as Front Panel Overlay.

The annotation on the crt display will not tell the user anything that couldn't be found out from the front panel data, but availability of the annotation will save the user the trouble of having to convert front panel to annotation if it is desired to make a hard copy with an interfacing device. For this reason, the ability to modify, and or output crt annotation is also available to the I/O. This data group is defined as Annotation.

A data group defined as Grids will locate the grid lines and is output in a numerical format compatible with the Trace data group.

The X-Y value of the cursor (in frequency and amplitude units), numerical value of display full and zero scale (again in amplitude units), and other items of information are provided in a 60 byte string defined as Calibration.

A status code byte is available to tell the user the operating status of the instrument (i.e., average in progress, transient armed, auto ranging in progress, etc.) so that the user can access data at the proper time.

3.1.2 Data/Control Accepted by the SD345

Time and Spectrum data can be input to the SD345. Trace is not configured for input as it is calculated in low resolution at the highest speed and there is no storage memory for it (i.e., the FFT is stored in LIN Y, LIN X and VOLTS. The calculations which resolve this with LOG distribution, expansion and units other than volts, are performed each time the display trace is updated).

Input of data to the SD345 is powerful enough that a user could, if desired, enter an externally generated signal array and obtain an FFT and a display array of that data or input an FFT recorded months earlier in LIN VOLTS and review it in dB versus LOG Hz.

Two other groups of data besides Trace are not available as inputs. These are Grids and Calibration. Both of these functions are performed automatically by the SD345 on the basis of the front panel settings.

Annotation is provided as an input to allow the user to modify the display annotation or to write messages on the crt while in the LIST mode.

Remote control of the instrument is achieved two ways. The 32-byte Front Panel Overlay defines one specific configuration of the SD345 front panel from frequency range to display mode. Input of a Front Panel Overlay will cause the SD345 to assume the configuration defined. The user can also enter single byte codes which will operate a single switch on the front panel. This data group is defined as Front Panel Single.

A special input/output is provided which is defined as ID Block. With the I/O card installed, a four digit ID number can be entered either externally or from the front panel. It will be displayed in the upper left hand corner of the display, output in the ID Block group and input/output as the first group of the multi-group strings defined as Data Set and Time Set (consisting of ID Block, Front Panel Overlay and Spectrum/Time in this order).

3.1.3 Interfacing with the SD345 I/O

The SD345 I/O is designed to interface through either an RS-232-C or an IEEE-488(75-78) port. This does not mean, however, that these are the only two ways to interface with the I/O. A recent article describes RS-232-C as the "nonstandard standard" and the fact that every IEEE device has a list of "functions implemented" shows that there is a great deal of variety in how the user may wish to apply these interfaces.

RS-232-C, though not defined as a handshake synchronous interface, can be made to approximate a handshake by using the modem control lines. Some devices never use these lines or do not use them in a manner compatible with the SD345 I/O. It is entirely possible, however, to simply not hook up the control lines and operate the I/O RS-232-C entirely on the transmit and receive lines.

Addressable IEEE is a bus application requiring a bus controller for operation. Without a bus controller, addressable IEEE is useless. It can, however, be operated in a talk only or listen only mode in which the three-wire handshake provides all the control of the data transfer, and there is no bus controller, just a dedicated talker and a dedicated listener. The SD345 can be either one. A rear-panel switch is provided to select IEEE (addressable, talk only or listen only) or RS-232-C.

The bus controller in addressable IEEE sends a number of bus control messages. Along with the address of a talking or listening device it may send a "secondary address" message. In the previous paragraphs the data available for input/output in the SD345 is divided into several groups. It was extremely useful to design the I/O so that each group would be identified by a unique secondary address. Effectively, by including a secondary address in the message, the bus controller would be telling the SD345 to "talk spectrum" or "listen Front Panel Overlay". In the talk only and listen only modes, where no bus messages are present, a rear-panel switch is provided to identify the data group for transfer.

One of the secondary addresses provided is defined as Control. This is for inputting commands to control the I/O itself. This command set is the control mnemonics which can initiate a data transfer, and/or determine the direction and nature of that transfer.

The RS-232-C port, when not engaged in something else, is always "listening" for these control mnemonics on its receive line. Since RS-232-C has no addressing capability, these control mnemonics must be used to initiate and select the transfer of a data group.

All transfer mnemonics are two characters in length. For example, execution of "SO" will cause spectrum data to be output. "SI" will cause spectrum data to be input.

The IEEE port has an "interface clear" line which allows a bus controller to immediately interrupt data transfer, and take control of the bus. The same effect can be achieved in RS-232-C by sending a break. The SD345 RS-232-C I/O will halt data transfer and return to the "listening for control mnemonics" mode. Other IEEE functions will cause internal responses in the SD345. "Remote enable" will cause the front panel controls to be locked out, and the Remote LED will light. "Local" reverses this process. In RS-232-C, the mnemonics "RE" and "LO" will cause the same respective responses. IEEE "device clear" will cause the SD345 to assume a Power-On-Initialize front panel setting (including the Power-On-Initialize of the I/O). "CL" in RS-232-C will illicit the same response. "RS" will cause the I/O alone to assume its power-on-default condition.

The last set of mnemonics is the "modifier". This determines the nature of the data transfer. Some users are capable of receiving data in ASCII only. Some are capable of, and prefer, handling data in binary. The SD345 I/O "remembers" what the format for data transfer was last set to and will output/input the data in that format, unless a modifier is added to the transfer mnemonic. To send spectrum data out in ASCII, "SO(A)" would be executed. If it is desired in binary the next time, it would be necessary to execute "SO(B)".

Because of the many variations in floating point format for various computing devices, spectrum data (the only non-integer data group) is available in a Spectral Dynamics Corporation standard format (SDC) and in a "customer format". The SDC format is indicated by the "D" modifier, and the "customer format" is indicated by "C". Currently there are two "customer formats" which can be provided; DEC and HP2100MX. The modifier applied execution would be the same; "SO(C)" or "SO(D)". It is possible to enter more than one modifier in an execution. "SO(CB)" would be "customer format" in binary. "SO(DA)" would be SDC format in ASCII.

Some interfacing devices, when sending in RS-232-C, require that the receiving device echo each character. The "E" and "Q" modifiers will effect this function when the SD345 is receiving data. "E" implements the echoing function. "Q" (for quiet) disables it.

The most useful pair of modifier characters are "I" and "R". These indicate IEEE and RS-232-C respectively. If "SO(I)" is sent in the RS-232-C port, spectrum data will be output from the IEEE port. This would be done in the IEEE talk only mode, effectively allowing RS-232-C to control the IEEE port. When the RS-232-C has control of the I/O it will make the proper internal settings to execute these modes of operation. Setting the RS-232-C switch on the rear panel causes the SD345 to power up in RS-232-C control. But this is not inflexible. Control is not an "executable" group, but the "E", "Q" and "I", "R" modifiers apply.

If a set of control mnemonics is terminated with a Carriage Return (CR), this is an "execute". The data transfer will commence. If terminated with a Line Feed (LF), there is no transfer, but the I/O remembers the modifiers in the string, and applies them when a transfer does occur. Control can be transferred the same way. "CO(I) LF" will hand control of the I/O over to the IEEE port. "CO(R) LF" will hand control over to the RS-232-C port. Either port can be controlled by the other.

Contained in the remaining portion of Section III are four tables of I/O specifics. These are: I/O Special Commands, Modifiers, Data Sets and Data Subsets. The major reason for the division is that modifiers cannot be added to Data Set Transfer mnemonics. Data and Time in the Data Sets are composites of ID Block, Front Panel Overlay and Spectrum/Time which are a combination of Data Subsets. Each group will be output/input in accordance with the modifiers currently stored for that group. What this means is, if it is desired to send a Data Set out of the IEEE port, the user must add the modifiers to the specific functions of the Data Set (ID Block, Front Panel Overlay and Spectrum/Time), and each Data Subset must be accessed, modified, and terminated with a Line Feed. (i.e., "ID(I) LF", "FO(I) LF", "SO(I) LF".) Now the specific Data Subsets which make up the Data Sets are configured for the desired output.

3.2 REAR-PANEL DIP SWITCHES AND SETTINGS

NOTE

There are two DIP switches located on the rear panel of the SD345 (refer to Figure 3-1). Each of these switches actually consists of eight separate switches. Any labeling on the switches themselves should be disregarded. Any reference to the labeling of these switches refers to the labeling on the rear panel.

Figure 3-1. Rear-Panel DIP Switches.

IEEE ADRS Switches (Switches 1 through 5)

These switches are used to select the IEEE primary address. The 0 and 1 located to the right of the switches denotes whether the switch is in the logical high or low position. Switch 1 represents the LSB of the address and the address is set up in positive true format, that is, the 1 position represents a binary '1' (logical high) and the 0 position represents a binary '0' (logical low). These switches must be set to the device address assigned to the SD345. When in the ADRSABLE mode, the Option will not respond to an external control request unless the requested address matches the setting of these switches. Each device must be assigned a unique 5-bit address code. This can be any 5-bit code except 11111.

NOTE

The Option reads these switches during POWER-UP INITIALIZATION. If any changes are made to these switches after POWER-UP INITIALIZATION, the Option will not recognize it until the next POWER-UP or LOGO INITIALIZATION.

POWER-UP INITIALIZATION: Takes place when the SD345 is first turned on. This is the same condition as the Initial POWER ON condition as explained in paragraph 3.5.1 in the SD345 User's Manual.

LOGO INITIALIZATION: Takes place when the front-panel LOGO is depressed and accomplishes the same as POWER-UP INITIALIZATION, plus recalls the front-panel information that has been stored by the PANEL, STORE touch control. (Refer to the SD345 User's Manual for information on the use of the PANEL, STORE touch control.)

ADRSABLE/TALK ONLY/LISTEN ONLY Switches (Switches 6 and 7)

These switches select between the ADRSABLE, TALK ONLY or LISTEN ONLY modes as follows:

SW7	SW6	
0	0	ADRSABLE
1	0	TALK ONLY
0	1	LISTEN ONLY
1	1	INVALID (An error message will be generated in this mode.)

ADRSABLE Setting

This switch setting is used when the SD345 is to be addressed by an external source.

TALK ONLY/LISTEN ONLY Settings

These switch settings are used when the peripheral connected to the SD345 has no control capability. For example, a digital plotter would require the SD345 to be in the TALK ONLY mode.

If the SD345 is in either of these modes, it will continuously check the status of the rear-panel switches for any changes. If it is desired to change from the TALK ONLY to the LISTEN ONLY mode or vice-versa, the front-panel LOGO will have to be depressed to reset the instrument after the change is made.

IEEE/RS-232 Switch (Switch 8)

This switch selects between IEEE and RS-232 operation. If it is desired, in RS-232 control, to transfer data in the IEEE TALK ONLY or LISTEN ONLY modes, it will be necessary to set the rear-panel TALK ONLY/LISTEN ONLY DIP switches in the TALK ONLY configuration.

AUX SW I/O FUNCT SET Switches (Switches 1 through 4)

These switches are used to select the secondary address to be used when the equipment is in the TALK ONLY or LISTEN ONLY modes of operation. The 0 and 1 located to the right of the switches denotes whether the switch is in the logical high or low position. Switch 1 represents the LSB of the address and the address is set up in positive true format, that is the 1 position represents a binary '1' (logical high) and the 0 position represents a binary '0' (logical low). The setting of these switches when in the TALK ONLY or LISTEN ONLY modes of operation, defines the type of data that is transmitted or received on the data lines.

AUX SW TEST Switches (Switches 5 and 6)

These switches are test functions. Information concerning the operation of these switches is contained in the Service Manual. When the equipment is not being tested or serviced, switches 5 and 6 should both be in the logical high (1) position.

AUX SW FST/SLO PLOT RATE Switch (Switch 7)

This switch selects analog plotter speed. If the 1/3 Octave Option is used while plotting, use only the SLO PLOT RATE position of this switch.

AUX SW OFF/ON CHAR Switch (Switch 8)

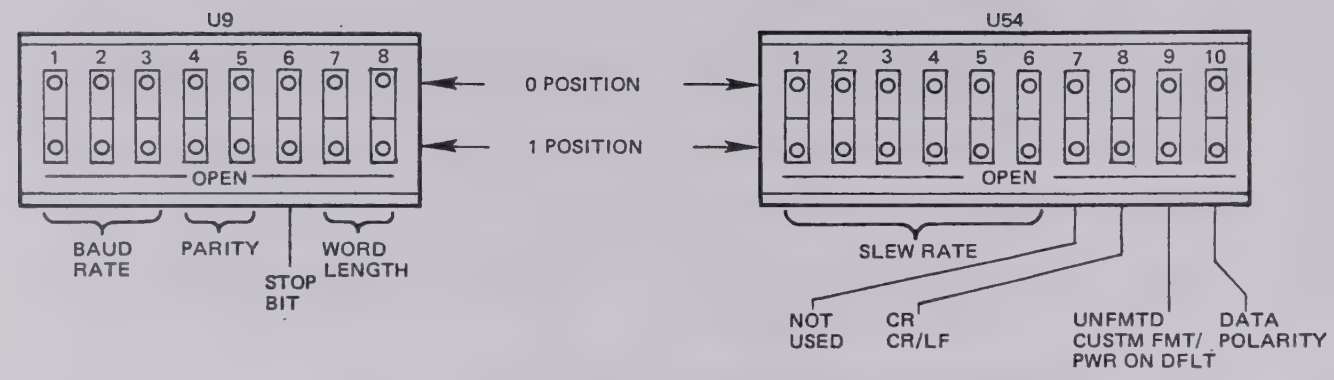
This switch turns the crt alphanumerics (all the numbers and letters) on or off. The grid and input data will remain.

3.3 I/O CARD DIP SWITCH SETTINGS

There are two DIP switches located on the I/O card. One is DIP switch U9, the other is DIP switch U54. DIP switch U9 has eight switches that select baud rate, parity, stop bits and word length. DIP switch U54 has ten switches that select slew rate, CR, CR/LF, format/power on default and data polarity. The switches and their settings are shown in Figure 3-2.

NOTE

Data cannot be input faster than 600 baud (continuous string), although any baud rate (up to 19.2k baud) can be input if there is a 1 millisecond pause between bytes.



DIP Switch U9

Switches 1 3

Setting	Baud Rate
000	110
001	300
010	600
011	1200
100	2400
101	4800 (out only)
110	9600 (out only)
111	19200 (out only)

Switches 4 6

SW4 – 0 = Even Parity
1 = Odd Parity

SW5 – 0 = No Parity
1 = Parity Enable

SW6 – 0 = 1 Stop Bit
1 = 2 Stop Bits

Switches 7 and 8

Setting	Word Length
00	Invalid
01	6 Bits
10	7 Bits
11	8 Bits

DIP Switch U54

Switches 1 6

All set to the 0 position

Switch 7 – Not used; should be set to the 1 position.

Switches 8 and 9

SW8 – 0 = CR
1 = CR/LF

SW9 – 0 = SDC format
1 = Customer Format/Power On Default

Switch 10

0 Position – Negative True
1 Position – Positive True

NOTE

Switch 10 on U54 should be set to the positive true position for RS-232 operation. If RS-232 operation is desired, the DIP switch on the rear panel of the SD345 should be set to RS-232 before turning power on.

Figure 3-2. I/O Card DIP Switches.

3.4 I/O SPECIFICS

Tables 3-1 through 3-4 list the I/O specifics referred to in paragraph 3.1.3 of this section. Table 3-1 is a list of the I/O Special Commands. These special commands are RS-232-C mnemonics which have the same internal effect as the IEEE interface messages. Table 3-2 is a list of the Modifiers. The modifiers are used to tell the I/O system how to send or receive data. Tables 3-3 and 3-4 list the Data Sets and Subsets. These are the data groups referred to in paragraph 3.1.3 with their corresponding secondary addresses and transfer mnemonics.

3.4.1 Using the Modifiers

The modifiers which can be loaded into the memory of the I/O Option are execution parameters for the various sets and subsets of data. Each set or subset will be executed in accordance with the remembered parameters. Modifier "I" (IEEE) or "R" (RS-232-C) will determine, as it is applied to the Control secondary address, which port has control. CO(I) LF will hand execution/modification control to the IEEE. CO(R) LF will hand control to RS-232-C.

Not all the modifiers affect all the subsets. For example, C and D (numerical data and format) applies only to FFT spectrum data. E and Q apply only to RS-232-C SD345 listen functions. A and B apply only to sets/subsets which can be obtained as binary data. ASCII only subsets are always ASCII.

Modifiers cannot be applied to data sets. DI/DO (secondary address 1) and TI/TO (secondary address 6) will successively execute ID Block, Front Panel Overlay and Spectrum/Time in accordance with the parameters stored for those data sets. HS (secondary address 2) has no modifiers; it is always SDC and binary. PL (secondary address 3) will come out of the port assigned to Trace, and always ASCII.

Modifiers applied to Input will affect Output. For example, FO(AI) LF (secondary address 13 with modifiers A and I) will cause FI to be ASCII, IEEE also.

3.4.1.1 Using ASCII

If the SD345 I/O is instructed to transfer data in ASCII, it will be important to know how the SD345 handles ASCII data. As an example, say, the value 1111_2 (F_{16}) is to be output to an ASCII device. In order for the ASCII device to receive F_{16}, it must be represented by some valid ASCII code. The SD345 sends to the ASCII device not HEX F (1111_2), but the ASCII character F, in this case, 46 which is bit pattern X100 0110. Also, if the character F were sent from an ASCII device to the SD345, the bit pattern would be X100 0110 (46), and the SD345 would interpret this as HEX F (1111_2). This information is true only if the data is input/output using the ASCII modifier when transferring data.

Table 3-1. I/O Special Commands

IEEE Interface Message	RS-232-C Mnemonic	Effect on the SD345
Remote	RE	Front-panel REMOTE LED indicator comes on. The front panel will not respond to local commands.
Local	LO	Front-panel REMOTE LED indicator goes out. Operator has control of the front-panel controls.
Device Clear	CL	The SD345 executes a "power-on-initialize." (Not a LOGO reset.)
Interface Clear	RS (Reset)	Resets the I/O system.

Table 3-2. Modifiers

Character	Function
R	Data to be handled through the RS-232-C port.
I	Data to be handled through the IEEE port.
E	Input characters are to be "echoed."
Q	Input characters are not to be "echoed." (Quiet.)
B	Data to input/output in binary as opposed to ASCII.
A	ASCII (Some subsets are always ASCII, not available in binary. In this case the "B" modifier will be ignored.)
C	Numerical (spectrum) data will be input or output in standard format. (Standard format is HP2100MX or DEC.)
D	Data is unformatted. (i.e., it will be handled in the internal or "SDC" format.)

Table 3-3. Available Data Sets

ASCII Only	Set Name	RS-232-C Control Mnemonic		IEEE Secondary Address		
		IN	OUT		IN	OUT
	Data	DI	DO	00001 (01)	X	X
	High Speed	—	HS	00010 (02)	—	X
X	Plotter	—	PL	00011 (03)	—	X
	Reserved	—	—	00100 (04)	—	—
	Reserved	—	—	00101 (05)	—	—
	Time Sets	TI	TO	00110 (06)	X	X
	Reserved	—	—	00111 (07)	—	—

Table 3-4. Available Data Subsets

ASCII Only	Subset Name	RS-232-C Control Mnemonic		IEEE Secondary Address		
		IN	OUT		IN	OUT
X	Control	CO	—	01000 (08)	X	—
	ID Block	II	ID	01001 (09)	X	X
	Status	—	ST	01010 (10)	—	X
	Reserved	—	—	01011 (11)	—	—
	Spectrum/Time Data	SI	SO	01100 (12)	X	X
	Front Panel Overlay	FI	FO	01101 (13)	X	X
	Grids	—	GR	01110 (14)	—	X
X	Annotation	AI	AO	01111 (15)	X	X
	Trace Data	—	TR	10000 (16)	—	X
	Calibration	—	CA	10001 (17)	—	X
	Time Data	IT	OT	10010 (18)	X	X
	Front Panel Single	FP	—	01010 (10)	X	—

3.4.2 Data Sets (Secondary Addresses 1 through 7)

Data sets are combinations of subsets or special applications of subsets. The following are brief descriptions of each data set. Data sets that require additional information are covered in paragraph 3.5, NUMERICAL DATA and subsequent paragraphs in this section.

Data (Secondary Address 1)

The data in or out is as follows: ID Block, followed by Front Panel Overlay, followed by a spectrum and always in this sequence. ID Block will not appear on the crt display when the instrument is in LISTEN ONLY and Data or Time sets are selected on the rear-panel I/O FUNCT SET switches. If a number for ID Block is entered, the instrument will accept the ID Block number and it will appear when the data is output. In other words, it's there, it's just not displayed on the crt. This applies to secondary addresses 1 and 6 only.

High Speed (Secondary Address 2)

High speed is a special application of spectrum which is fast enough to output every ensemble calculated. It is always in binary, always in SDC format and always output via the IEEE port. Echo and Quiet do not apply to IEEE. The entire ensemble must be removed as soon as it is available and transfer of the ensemble is not to take longer than 80 milliseconds. It is recommended that the user should not make any changes to the front panel or the I/O until the desired data is output. The reason for this is that when outputting ensembles at high speed the SD345 is effectively in a TALK ONLY configuration with short duration addressable windows appearing between each ensemble. When the operator has obtained sufficient data in high speed, it must be terminated by entering a secondary address through the "addressable window" between the ensembles. After the secondary address is entered, to insure that the I/O and the SD345 will be reset from the high speed TALK ONLY parameters, the user should now execute a Device Clear (CL).

Plotter (Digital Plotter — Secondary Address 3)

Output only. The data is: Plotter trace data, grids and annotation output with HP-GL or TEK 4662 instructions to actually create a graphics plot on a graphics peripheral that is HP-GL or TEK 4662 compatible. This secondary address is available only with options of the -3X01 and -3X02 configurations. Refer to the subsection on Digital Plotter in this section for more information.

Time Sets (Secondary Address 6)

The data in or out is as follows: ID Block, followed by Front Panel Overlay, followed by Time Data and always in this sequence.

3.4.3 Data Subsets (Secondary Addresses 8 through 18)

The following are brief descriptions of each data subset. Data subsets that require additional information are covered in paragraph 3.5, NUMERICAL DATA and subsequent paragraphs in this section.

Control (Secondary Address 8)

This is a special case, such as RS-232-C, which has no secondary address and is always in the control mode when:

1. Control is set to RS-232-C.

2. No other subset or set is being executed.

(Control is input, only, of the set/subset mnemonics plus special command mnemonics and modifiers.) Input of a subset mnemonic and modifiers, terminated by a LINE FEED (LF) stores the affect of these mnemonics without execution. If terminated with a CARRIAGE RETURN (CR), the set/subset is executed.

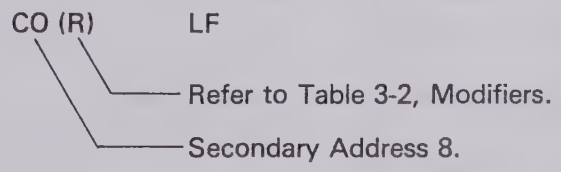
Use of control mnemonics through secondary address 8 in IEEE can modify (with modifiers) the input/output of other secondary addresses if terminated by a LF or cause execution of sets/subsets without use of secondary addresses to access them. This can be useful in systems with limited IEEE software capability.

Briefly: IEEE — Modify through Control
Execute through Secondary Addresses

RS-232-C Control — Modify with a LF
Execute with a CR

An example of IEEE passing control to RS-232-C is as follows:

If the SD345 has been powered up in the IEEE mode, and it is desired to turn command control over to RS-232, the instruction from the IEEE controller will be:



As soon as the internal system sets up the RS-232 as the command, as in all functions, the SD345 will issue a CR LF and the RS-232 device must be prepared to receive the sequence.

In RS-232-C control, designating a subset for IEEE will drive the system to Talk or Listen Only. This may not be desired. To place the SD345 in IEEE addressable, it will be necessary to execute a device clear (CL) or Logo reset prior to CO(I) LF for proper operation.

ID Block (Secondary Address 9)

This is an ID number input by the user to identify an ensemble.

Status (Secondary Address 10)

Output only. This is a single byte which indicates the operating status of the SD345.

Spectrum/Time Data (Secondary Address 12)

Time mode data is always two bytes per cell with a total of 1024 cells. The format for spectrum data is determined by inputs to the I/O software. Input of spectrum data will always go to M1 (except the time mode). Output can be RT, M1 or M2. The I/O expects a number of bytes which are formatted in accordance with the I/O software status (formatted or unformatted) and the number is determined by the selected mode (i.e., Narrowband, 1/3 Octave and 1/1 Octave).

Front Panel Overlay (Secondary Address 13)

This is a 32 byte string of data defining the front-panel settings. As an output it can tell external software the current front-panel setting of the SD345. As an input it can be used to drive the SD345 to a desired front-panel configuration.

Grids (Secondary Address 14)

This is numerical data giving the location of each grid line on the crt display. Output only.

Annotation (Secondary Address 15)

The annotation on the crt is output line by line at 64 characters per line. As an input the first byte is the line number. If in LIST, each line is to be 32 characters long with 15 lines. This is intended for external writing of messages on the crt. If in OPER, each line is to be 64 characters long with 6-12 lines. This is for modification of display annotation.

Trace Data (Secondary Address 16)

This is raw numerical data used in graphics to create a trace.

Calibration (Secondary Address 17)

This is a 60 byte string of data giving certain special information such as cursor units, value of grid full scale, value of grid 0 scale, etc. Output only.

Time Data (Secondary Address 18)

Numerical data and format is the same as the Time data for secondary address 12. A typical application of this secondary address could be as follows: An FFT of externally generated time data can be performed as follows: The SD345 first be in the TIME mode when time data is input. After the time data is input, depress the front-panel + 1 touch control. This will perform a SYNC TIME AVG on the input data. Select the SPECT mode, MENU selection 4 (SYNC SPECTRUM). Depress OPER. An FFT of the input time data will be displayed.

Front Panel Single (Secondary Address 10)

Input only. One byte. This has the same effect as depressing a front-panel touch control. The touch control to be depressed is determined by the value of the byte. Although this has the same secondary address as Status, it should be noted that Status is output only and Front Panel Single is input only.

3.5 NUMERICAL DATA

3.5.1 Choosing Correct Data

In certain configurations of the SD345 the desired data may not be readily available. Two basic examples are: Dual Trace and Sensitivity.

The numerical data read for sensitivity will be the data value for the sensitivity setting. If TH% is set, MV/EU cannot be read. This can be solved by having the computer write the correct control number on secondary address 10 (Front Panel Single) to set the sensitivity in the right place, and then rereading the Front Panel Overlay (secondary address 13).

Also, the data set from the I/O will be for the trace where the cursor is currently placed. If the upper trace data is desired, and the cursor is in the lower trace, it will be necessary to set the cursor in the upper trace to access the data via secondary address 10.

3.5.2 SD345 "BCD" Format

The code used for the numerical information included in the Front Panel Overlay and the Calibration data for cursor cell location and sensitivity setting is in a special format. Each byte is a digit and the entire four byte set is right justified. The HEX code and the equivalent SD345 "BCD" code is shown in Table 3-5.

Table 3-5. SD345 "BCD" Format

Hex Code	SD345 "BCD" Equivalent
00-09H	0-9
0A-0EH	Never Present
0FH	Blank Space
10H-19H	0.-9.
1AH-2EH	Never Present
2FH	"–" (minus sign)
45H	"E" (exponential notation)

3.5.3 Spectrum Data (Secondary Addresses 1 and 12)

"What you see is what you get" is the general rule for reading spectrum data from the SD345. That is, if single trace spectrum data is displayed on the crt, that will be the spectrum data that is read from the SD345. If a dual trace is displayed, the data that is read will be the spectrum on which the cursor is placed. If a dual trace is desired as an output, the display must not be set to a mixed dual trace (i.e., spectrum and time or vice-versa). As displays are changed from dual to single trace there is no need to change the CURSOR group UPPER/LOWER control. This is automatically done within the SD345.

Spectrum data is not available when the front-panel controls are set to LIN X, X4 and LOG X (NB). These "distributions" affect the content of *Trace* data, not spectrum. Narrow Band spectrum is available only in LIN X, X1. For example, if the Spectral Dynamics supplied plotter program for the HP9825A calculator is being used (-3 and -3X00 configurations), and an output of spectrum data is desired, the calculator will reset the front panel to LIN X, X1, access the data, and then return the equipment to the previous front panel configuration.

The data that is read will correspond to the SD345's mode of operation (i.e., 1/3 Octave, 1/1 Octave or Narrow Band). When dealing with the 1/1 Octave or 1/3 Octave modes, if 400 data points were read most of the values would be redundant. For this reason, when selecting the octave modes, only one value of each octave step will be read. This results in 31 values (30 data values plus an overall) for the 1/3 octave and 11 values (10 data values plus an overall) for the 1/1 octave data. Examples of the data formats are as follows:

Narrow Band and Translator — 401 cells × 4 bytes/cell = 1640 bytes
1/3 Octave — 31 cells × 4 bytes/cell = 124 bytes
1/1 Octave — 11 cells × 4 bytes/cell = 44 bytes

All spectrum data is in a linear magnitude format (i.e., $(mag^2)^{1/2}$; thus it is unipolar positive) consisting of a 24-bit full floating point fraction with sign and a 7-bit exponent with a one-bit sign as shown in Figure 3-3. This is the floating point format of the HP2100MX minicomputer family.

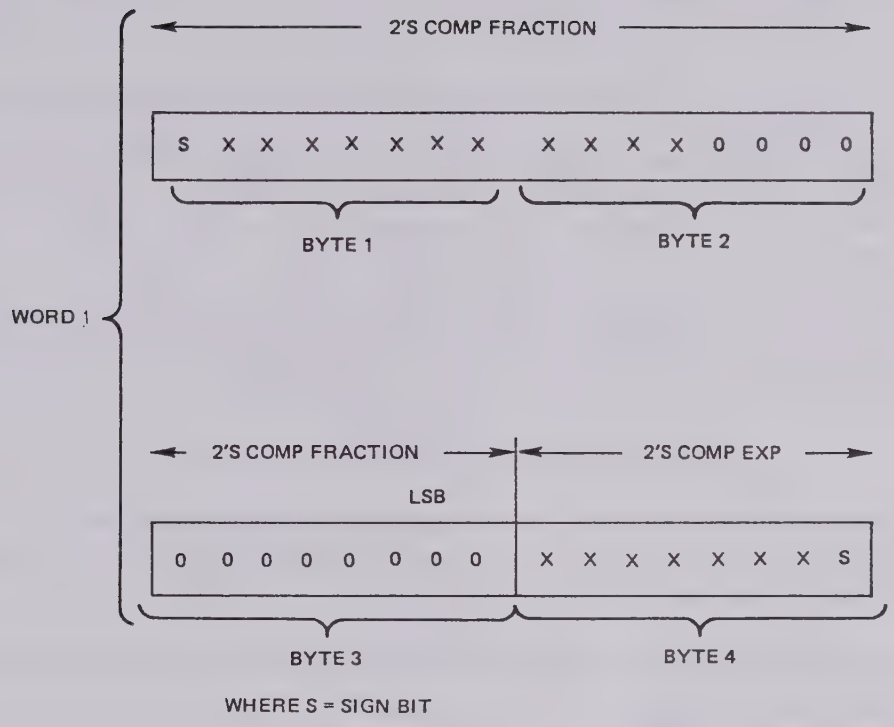

2'S COMP FRACTION
S X X X X X X X
X X X X 0 0 0 0
BYTE 1
BYTE 2
WORD 1
2'S COMP FRACTION
2'S COMP EXP
LSB
0 0 0 0 0 0 0 0
X X X X X X X S
BYTE 3
BYTE 4
WHERE S = SIGN BIT

Figure 3-3. Floating Point Format.

The fraction data is in 2's complement format with sign. The high order bit (bit 7 of byte 1) is the sign of the fraction. The remaining bits of byte 1 and the 4 high order bits (bits 7, 6, 5 & 4) of byte 2 comprise the valid data from the SD345. The remaining bits (3, 2, 1 & 0) of byte 2 and all of byte 3 are data zeros. These bits are beyond the SD345's accuracy but are sent to comply with the requirements of the HP2100MX format.

Logic within the SD345 permits processing of signal levels greater than the selected input level. However, there is an upper limit beyond which the instrument can no longer perform meaningful calculations. Therefore, for purposes of reading the fractional data from the SD345, a representation of nominal full scale (0 dB) and the maximum fraction that can be read (+1.2 dB) are shown in Figure 3-4.

The maximum fraction data value is equivalent to about 1.2 dB greater than the input level selected. In both cases, of course, bytes 3 and 4 will contain all zeros.

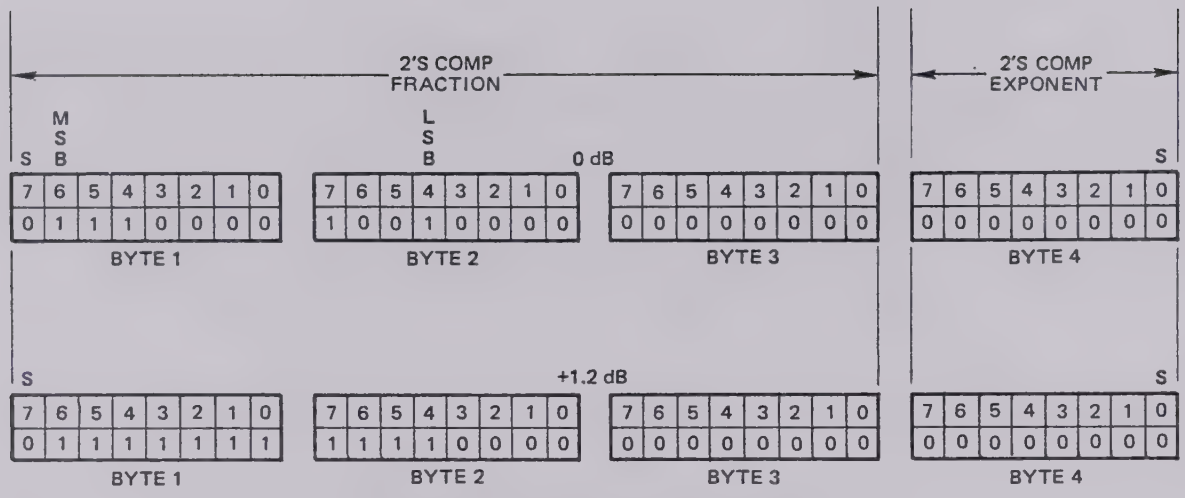


Figure 3-4. Fractional Data of Figure 3-3.

Byte 4 contains the exponent and sign, where the sign is the low order bit (bit 0). The exponent data is arranged so that a "0" exponent (byte 4 = 0) represents the full scale value of the data. All exponent values other than zero will be negative (i.e., bit 0 = 1).

After conversion from the 2's complement format, the numbers in the spectrum mode are:

Full Scale (Input Level) = 28816

Possible range of exponent: +01 to −29

Formula

After conversion from HP2100MX format to decimal numbers, the linear expression for spectrum data is:

$[(256 \times \text{byte 1} + \text{byte 2}) \times 2^{exp}] / 28816 = \%$ of full scale (lin value, ratio)

20 log (% of full scale) = dB full scale

When spectrum data is to be read, recorded, and later reloaded back into the SD345, the front panel status data should also be read and recorded with the spectrum. If the data read is an average in memory M1, of say 16 ensembles, it is normalized to an ensemble of one as it is read out. That is, the data read is not the sum set but the sum set divided by 2^n where n = 0, 1, 2, 3, . . . 10.

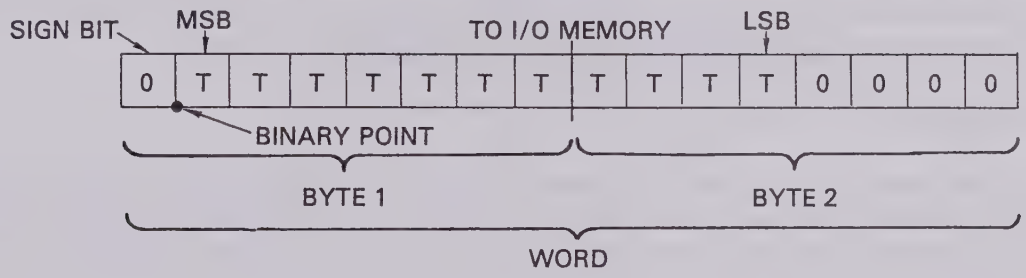
NOTE

For example, if an average is halted on the 12th ensemble, the data read will be the sum set of 12 ensembles divided by 2^4 or 16 (four right shifts).

If previously read data is reloaded into the SD345, the SD345's INPUT LEVEL when it is recorded must be the same as the INPUT LEVEL when the data was read so that internal calculations will be performed correctly. Therefore, the INPUT LEVEL and FREQ RANGE (at least) should be read and carried with spectrum data and loaded back into the SD345 just prior to the reloading of the data.

3.5.4 Time Mode Data Out (Secondary Addresses 6, 12, 18)

This is raw numerical data linearly distributed at all times (independent of crt LOG/LIN distribution). Time data output available to I/O memory consists of 1024 cells of fixed point or integer data (averaged or non-averaged). Each cell to I/O memory exists as an 11 bit positive integer where 4000H (16384_{10}) represents 0 volts dc, 78A0H (30880_{10}) represents the positive peak voltage and 760H (1888_{10}) represents negative peak voltage. The Z80 Microprogram reformats the data in I/O memory to a standard 16 bit integer format by shifting the binary point left and inserting zeroes in the 4 LSB's. The reformatted data in I/O memory ready for output is shown below.



Since all numbers are positive, the sign bit will always be zero. The 1024 16 bit words are output eight bits at a time with byte 1 followed by byte 2 for the first word and repeated for each remaining word.

Peak value will be determined by the Input Level and the RMS, P-P and 0-P modes. In RMS it is the input times 1.41 (2) which is plus peak. In P-P one-half the Input Level is peak and in 0-P the Input Level is peak.

Formula

To calculate the deviation from minus peak to plus peak, (which is fundamentally how the time mode information comes out) the formula will be:

(256 byte 1 + byte 2 − 1888)/28992 = % from − peak to + peak

Note: 28992 = 30880 − 1888

3.5.5 Time Mode Data In (Secondary Addresses 6, 12, 18)

The format for time mode data into the I/O memory is the same format as the output data. Byte 1 is input first followed by byte 2 until 1024 words are input. Time mode data can be input to the SD345 while the instrument is in the TIME mode as follows:

SD345 in the TIME mode:

Secondary address of 6 for Time Data Sets or

Secondary address of 18 for Time Data only.

The SD345 Input Memory will go to the HOLD mode and the instrument will continuously display or average time data using the I/O memory time data as a source. When UPDATE is selected, the SD345 will resume displaying or averaging time data from its own Input Memory.

TALK ONLY/LISTEN ONLY Modes

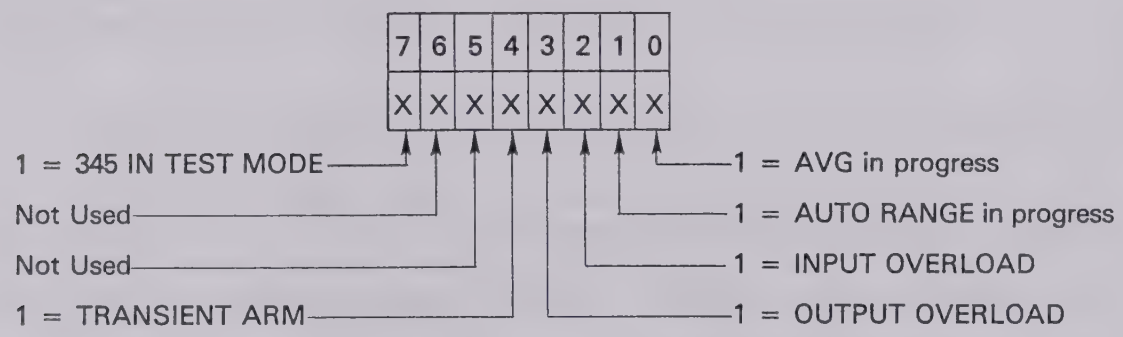
When the TALK ONLY or LISTEN ONLY modes of operation are manually selected by utilizing the SD345 rear-panel DIP switches, secondary addresses above 15_{10} (1111_2)cannot be selected as address selection for these two modes is via the rear-panel I/O FUNCT SET DIP switches. There are only four of these switches, therefore a secondary address of 17_{10} (10001_2), Calibration, for example, cannot be selected in the TALK ONLY/LISTEN ONLY modes.

Secondary address 18, in TALK ONLY/LISTEN ONLY, is a special case. Although secondary address 18 cannot be selected on the I/O FUNCT SET DIP switches, by selecting a function set of 7_{10} (0111_2), the instrument will interpret this, in this case, as secondary address 18.

3.5.6 Status (Secondary Address 10)

The internal operation status of the SD345 as it relates to data read is available by requesting Secondary Address 10. One data byte is read with the request. The instrument is in a particular operating condition if the bit within the byte that represents that condition is on. These six operating conditions are designated within the byte as follows:

STATUS BYTE


7 6 5 4 3 2 1 0
X X X X X X X X
1 = 345 IN TEST MODE
Not Used
Not Used
1 = TRANSIENT ARM
1 = AVG in progress
1 = AUTO RANGE in progress
1 = INPUT OVERLOAD
1 = OUTPUT OVERLOAD

Programming of the external device should be designed to consider these particular aspects of the SD345's operating condition. For example, while auto ranging, spectrum data may be changing and should not be requested until auto ranging has stopped.

An example of reading the status byte using the HP9825A is:

rdb (70110) – > X

3.5.6.1 AVG in Progress

This bit is set to a logical one if the machine is in process of averaging and the selected number of averages has not been reached.

a. LIN AVG: The bit resets when the machine halts averaging.

b. EXPO AVG: The bit resets when the machine transfers from LIN AVG to EXPO AVG.

c. PEAK AVG: The bit remains set until AVG STOP is depressed.

3.5.6.2 AUTO RANGE In Progress

This bit is set when the AUTO RANGE touch control is turned on. During the auto range process, the input and/or output sections may become overloaded. This situation will set respective overload status bits. However, when auto ranging is complete, the bit will reset.

NOTE

Nonstationary random noise signal sources may cause additional temporary input overload after auto ranging is complete. This is an acceptable condition.

3.5.6.3 INPUT OVERLOAD

When the A/D digital output for any single cell sampled exceeds about 90% of full scale, an Input Overload signal is generated and the Input Overload status bit is set.

3.5.6.4 OUTPUT OVERLOAD

When any spectrum point exceeds the crt display range (crt full scale) the front-panel Output Overload LED will light and the Output Overload status bit will be set.

3.5.6.5 TRANSIENT ARM

This bit is set when the TRANSIENT CAPTURE function is armed.

3.5.6.6 345 IN TEST MODE

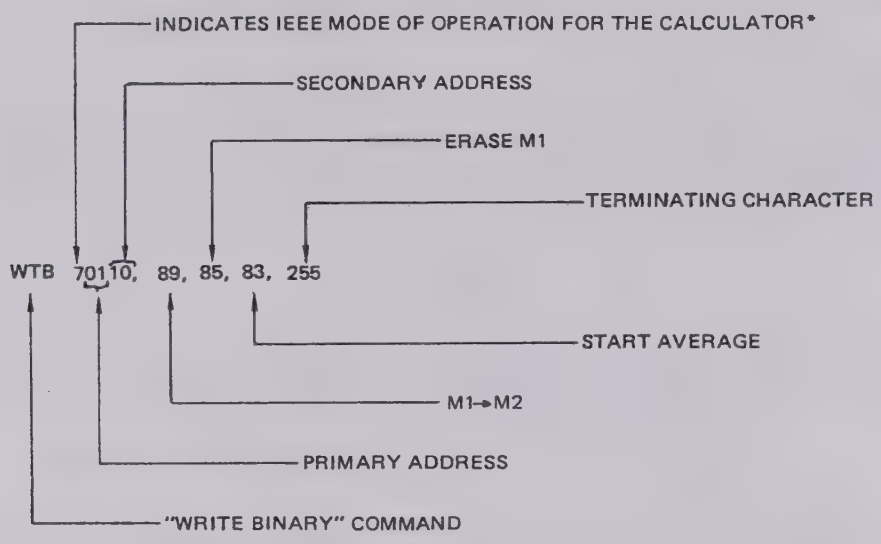
This bit is set when the SD345 is in the TEST mode of operation.

3.5.7 Front Panel Single (Secondary Address 10)

This method of front panel control is achieved by writing a string of bytes (minimum string = 1 byte), comprising the touch control "codes" (Table 3-6), terminated by a termination character (CR if in ASCII, FF (255) if in binary).

The following is an example using the HP9825A calculator to write a string into the SD345 that will sequentially transfer data from M1 to M2 Memory, erase M1 and restart the averaging process. The calculator sends a write binary command, primary address and secondary address, followed by a sequence of one or more data bytes for the appropriate switch setting (refer to Table 3-6 for switch setting codes).

This string will be input to the SD345 with a terminating byte of 255_{10} or FF_{16}. In turn, the SD345 will accept these three changes, interpret them and implement the changes in the order in which they are received, completing the implementation of one before starting the next.



*Actually is "select code 7", the default of the IEEE I/O card in the calculator; could be any number if card select code is otherwise.

Table 3-6. Front Panel Single Data Byte Values

Group Design	Control Group	Operational Function	Decimal Code	Binary Code	Hex Code
A	CURSOR X UNITS	Hz	0	00000000	00
		KCPM	1	00000001	01
		ORDER	2	00000010	02
B	CURSOR Y UNITS	V	3	00000011	03
		dB	4	00000100	04
		EU	5	00000101	05
		PSD	6	00000110	06
C	CURSOR CONTROL	NORM	7	00000111	07
		HMNC	8	00001000	08
		ΔX	9	00001001	09
		ΔP	10	00001010	0A
		ADRS	11	00001011	0B
		SET REF on/off	12	00001100	0C
		RESET cursor	13	00001101	0D
		UPPER cursor	14	00001110	0E
		LOWER cursor	15	00001111	0F
D	SENSITIVITY	dB REF	16	00010000	10
		TH%	17	00010001	11
		mV/EU	18	00010010	12
		ENTER	19	00010011	13
		RECALL	20	00010100	14
E	SENSITIVITY KEYBOARD	0	21	00010101	15
		1	22	00010110	16
		2	23	00010111	17
		3	24	00011000	18
		4	25	00011001	19
		5	26	00011010	1A
		6	27	00011011	1B
		7	28	00011100	1C
		8	29	00011101	1D
		9	30	00011110	1E
F	TRANSLATOR	ON/OFF	31	00011111	1F
		ZOOM SET	32	00100000	20
		ZOOM 10	33	00100001	21
		ZOOM 20	34	00100010	22
		ZOOM 50	35	00100011	23
		ZOOM 100	36	00100100	24
		GAIN 1	37	00100101	25
		GAIN 2	38	00100110	26
		GAIN 4	39	00100111	27
		GAIN 8	40	00101000	28
G	FREQ RANGE	UP (arrow)	41	00101001	29
		DOWN (arrow)	42	00101010	2A
		WTG (ON/OFF)	43	00101011	2B

Table 3-6. Front Panel Single Data Byte Values (Continued)

Group Design	Control Group	Operational Function	Decimal Code	Binary Code	Hex Code
H	INPUT LEVEL	UP (arrow)	44	00101100	2C
		DOWN (arrow)	45	00101101	2D
		AUTO ON/OFF	46	00101110	2E
		RMS	47	00101111	2F
		P-P	48	00110000	30
		O-P	49	00110001	31
I	SIGNAL INPUT	TRANS ARM ON/OFF	50	00110010	32
		ACST WTG ON/OFF	51	00110011	33
		HOLD	52	00110100	34
		UPDATE	53	00110101	35
		TEST	54	00110110	36
		AC	55	00110111	37
		DC	56	00111000	38
J	X DISPLAY	LIN	57	00111001	39
		X1	58	00111010	3A
		X4	59	00111011	3B
		LOG	60	00111100	3C
K	Y DISPLAY	LIN	61	00111101	3D
		LOG	62	00111110	3E
		GAIN (up arrow)	63	00111111	3F
		GAIN (down arrow)	64	01000000	40
L	PLOTTER	RESET	65	01000001	41
		START	66	01000010	42
		STOP	67	01000011	43
		CAL	68	01000100	44
		0, 0.1	69	01000101	45
		FS	70	01000110	46
M	FUNCTION	SPECT	71	01000111	47
		TIME	72	01001000	48
		M1, M2	73	01001001	49
		LIST	74	01001010	4A
		SEL	75	01001011	4B
		OPER	76	01001100	4C
N	AVG	LIN	77	01001101	4D
		EXPO	78	01001110	4E
		PEAK	79	01001111	4F
		Up arrow	80	01010000	50
		Down arrow	81	01010001	51
		+1	82	01010010	52
		START	83	01010011	53
		STOP	84	01010011	54
		ERASE	85	01010101	55

Table 3-6. Front Panel Single Data Byte Values (Continued)

Group Design	Control Group	Operational Function	Decimal Code	Binary Code	Hex Code
O	SPECTRUM	NB	86	01010110	56
		1/1 OCT	87	01010111	57
		1/3 OCT	88	01011000	58
P	SPECIAL	M1→M2	89	01011001	59
		PRGM SEL	90	01011010	5A
		PANEL STORE	91	01011011	5B
		LOGO	92	01011100	5C
		C BREAK	93	01011101	5D
		NO SWITCH	94	01011110	5E

3.5.8 Front Panel Overlay (Secondary Address 13)

Front panel status is passed between the SD345 3000 Microprocessor (internal processing) and the Z80 Microprocessor (front-panel interface) through a mutually accessible memory referred to as a "Mailbox". The format and sequence of data stored in the Mailbox becomes the criteria used in formatting and sequencing data through the I/O Option card. This formatting and sequencing is shown in Table 3-7.

The 32 bytes of data will be read, when the front panel data is requested (secondary address 13), is an overlay of the internal Mailbox. This Mailbox structure greatly simplifies setting up the front panel controls from an external device by establishing the same format, sequencing, source and destination for the external device to read from or write into.

The Front Panel Overlay allows the external device to read the present front panel status, change any desired settings, and write the updated panel data back into the SD345.

However, the external device can retrieve from its memory (or create) a pattern of all 32 bytes in a configuration desired and send the array into the SD345. There is no need to read the front panel before changing a value and sending it back. But a full array of 32 bytes must be sent and care must be taken not to inadvertently change something that should not be changed.

NOTE

Care must be taken to prevent writing a data byte which is outside the specified values shown in Table 3-7. There is no internal protection system for an excessive value and system operation is unpredictable.

The Front Panel Overlay method is divided within the SD345 into two general types of controls:

a. The changing of states by simple overlay (as in bytes 1 through 11 where a single function is changed such as Hz to KCPM, etc.).

b. A sequence of steps (as in bytes 16 through 27 where more than one step is required to effect a single change such as SENSITIVITY).

When the system is resolving the second type, the front panel may be observed to change states several times until the final desired result is achieved. This is normal.

Three areas of control take special note. They are:

a. Setting the cursor (bytes 12-15).

b. SENSITIVITY (bytes 20-23).

c. Display Mode (byte 16).

Since it is difficult to determine if and when a change is actually desired, additional control bits have been added. Whenever it is not desired to change the Cursor, Display Mode or SENSITIVITY, additional bit 1, bit 3, and bit 2 respectively of byte 27 must be reset.

Several of the features share common machine states. The operator must be aware of the possible consequences. For example, if the Octave Option card is not in the instrument and the option is selected, an OPTION AVAILABLE message is generated followed by the instrument resetting. If Octave and List Display (byte 26) are selected at the same time, the option message and reset has a higher priority and it may appear that the instrument is not functioning properly. An inspection of what is actually being requested can quickly resolve problems of this nature.

In Table 3-7 note that the data byte content flows in a logical pattern from "0" equating to the high order position of the touch control setting to the highest number data byte equating to the lowest setting for each function control.

Bytes 24, 25, 26 and 27 are bit by bit indicators of various functions or states of the machine. When read, some of the bits which represent one-shot (toggle) actions, are always zero and do not indicate if that one-shot function is in effect. Such touch controls are ENTER, AVG ERASE, XFER M1 to M2 for example.

Bytes 28 through 32 are "read only" bytes and relate to data as represented in specific memories. The Input Overload relates to Real Time Memory, Output Overload to CRT Memory and the BCD number of averages actually taken to M1 Memory.

The Front Panel Overlay method is very fast and effective for changing the SD345 front panel controls. In some cases this method is more effective than manual changes. For example, from the front panel touch controls, the values for FREQ, LEVEL, GAIN and AVG select can be incremented or decremented only one unit at a time (up/down arrows), but when using the Front Panel Overlay method, values from minimum to maximum can be set for these functions directly in one overlay transfer (write) operation.

This method is not convenient, however, if the instrument's operating states must be changed in a particular sequence such as "Transfer M1 to M2, erase M1, and restart the average". This sequence of changes cannot be done in one Front Panel Overlay transfer. In fact the Overlay method would require 3 passes of 32 byte data or a 96 byte (plus control) transfer. To sequentially change instrument operating conditions the Front Panel Single method is more efficient.

Table 3-7. Front Panel Overlay Data Format

Byte Number	Control	Operational Function			Binary Code	Hex Code
1	CURSOR UNITS	Hz			00000000*	00
		KCPM			00000001	01
		ORDERS			00000010	02
2	CURSOR Y UNITS	V			00000000	00
		dB			00000001*	01
		EU			00000010	02
		PSD			00000011	03
3	CURSOR MODE	NORM			00000000*	00
		HMNC			00000001	01
		ΔX			00000010	02
		ΔP			00000011	03
4	AVG N	1024 Avg Ensembles			00000000	00
		512 Avg Ensembles			00000001	01
		256 Avg Ensembles			00000010	02
		128 Avg Ensembles			00000011	03
		64 Avg Ensembles			00000100	04
		32 Avg Ensembles			00000101	05
		16 Avg Ensembles			00000110*	06
		8 Avg Ensembles			00000111	07
		4 Avg Ensembles			00001000	08
		2 Avg Ensembles			00001001	09
5	AVG MODE	LIN			00000000*	00
		EXPO			00000001	01
		PEAK			00000010	02
6	Y-GAIN	LOG	LIN			
		+30	0.125		00000000	00
		+20	0.25		00000001	01
		+10	0.5		00000010	02
		0	1		00000011*	03
		−10	2		00000100	04
		−20	5		00000101	05
		−30	10		00000110	06
7	FREQ RANGE	**NB**	**1/3 OCT**	**1/1 OCT**		
		100 kHz	80 kHz	63 kHz	00000000	00
		50 kHz	40 kHz	31.5 kHz	00000001	01
		20 kHz	20 kHz	16 kHz	00000010	02
		10 kHz	10 kHz	8 kHz	00000011*	03
		5 kHz	5 kHz	4 kHz	00000100	04
		2 kHz	1.25 kHz	1 kHz	00000101	05
		1			00000110	06
		500 Hz			00000111	07
		200 Hz			00001000	08
		100 Hz			00001001	09
		50 Hz			00001010	0A
		20			00001011	0B
		10			00001100	0C
		5			00001101	0D
		2			00001110	0E
		1			00001111	0F

*Power on Default.

Table 3-7. Front Panel Overlay Data Format (Continued)

Byte Number	Control	Operational Function	Binary Code	Hex Code
8	INPUT LEVEL VOLTS	20V	00000000	00
		10V	00000001	01
		5V	00000010	02
		2V	00000011	03
		1V	00000100*	04
		500 mV	00000101	05
		200 mV	00000110	06
		100 mV	00000111	07
		50 mV	00001000	08
		20 mV	00001001	09
		10 mV	00001010	0A
9	TRANSLATOR ZOOM	10	00000000*	00
		20	00000001	01
		50	00000010	02
		100	00000011	03
10	TRANSLATOR GAIN	1	00000000*	00
		2	00000001	01
		4	00000010	02
		8	00000011	03
11	LEVEL	RMS	00000000*	00
		P-P	00000001	01
		O-P	00000010	02
12	CURSOR UNITS	Cell value (BCD) at cursor location in UNITS selected (MSB)	XXXXXXXX	—
13			XXXXXXXX	—
14			XXXXXXXX	—
15		(LSB)	XXXXXXXX	—
16	Display MODE**	M2/M1	00000000	08
		M1/M2	00000001	01
		M2 – M1	00000010	02
		M1 – M2	00000011	03
		M1 + M2	00000100*	04
16	Display Mode†	TIME	00000000*	00
		SYNC TIME AVG	00000001	01
		TIME, RT	00000010	02
		TIME, M1	00000011	03
		TIME, M2	00000100	04

*Power on Default.

**If Byte 17 selects M1, 2.

†If Byte 17 selects TIME.

Table 3-7. Front Panel Overlay Data Format (Continued)

Byte Number	Control	Operational Function	Binary Code	Hex Code
16	Display Mode‡	RT	00000000*	00
		M1	00000001	01
		M2	00000010	02
		SYNC SPECTRUM	00000011	03
		RT, M1	00000100	04
		RT, M2	00000101	05
		M1, M2	00000110	06
17	FUNCTION DISPLAY	SPECT	00000000*	00
		TIME	00000001	01
		M1, M2	00000010	02
18	SPECTRUM	NB	00000000*	00
		1/1 OCT	00000001	01
		1/3 OCT	00000010	02
19	SENSITIVITY	dB REF	00000000	00
		TH%	00000001	01
		mV/EU	00000010*	02
		ENTER	00000011	03
20	SENSITIVITY	BCD value of number (MSB)	XXXXXXXX	—
21	KEYBOARD	entered	XXXXXXXX	—
22	NUMBER		XXXXXXXX	—
23		(LSB)	XXXXXXXX	—
24	CURSOR	Turn on cursor SET REF	XXXXXX10	
	CURSOR	Turn off cursor SET REF	XXXXXX00	
	ENTER	Enter value (bytes 20—23)	XXXXX1X0	
	AVG START	Start averaging	XXXX1XX0	
	AVG STOP*	Stop averaging	XXXX0XX0	
	AVG ERASE	Delete current average DATA	XXX1XXX0	
	AVG +1	Add +1 to N Average	XX1XXXX0	
	XFER M1→M2	Place M1 contents in M2	X1XXXXX0	
	ZOOM SET	Set Zoom Center	1XXXXXX0	
	ZOOM SET	Turn off ZOOM SET	0XXXXXX0	
25	Y LOG	Set LOG Y display	XXXXXXX1	
	Y LIN*	Set LIN Y display	XXXXXXX0	
	X4 (X-Gain)	Expand X display X4	XXXXXX1X	
	X1 (X-Gain)*	Set X display to unity	XXXXXX0X	
	PLOTTER START*	Set OPERATE Mode	XXXXX1XX	
	PLOTTER CAL	Set zero CAL Mode	XXXXX0XX	

*Power on Default.

‡If Byte 17 selects SPECTRUM.

Table 3-7. Front Panel Overlay Data Format (Continued)

Byte Number	Control	Operational Function	Binary Code	Hex Code
	PLOTTER FS	Set zero pull scale CAL	XXXX1XXX	
	PLOTTER 0.01	Set 0.01 CAL Mode	XXXX0XXX	
	INPUT AUTO	Set automatic input level	XXX0XXXX	
	INPUT AUTO	Reset automatic input level	XXX1XXXX	
	UPDATE*	Set memory UPDATE switch	XX1XXXXX	
	HOLD	Set memory hold switch	XX0XXXXX	
	TRANS ARM	Set TRANS ARM	X1XXXXXX	
	TRANS ARM	Reset TRANS ARM	X0XXXXXX	
	X LOG	Set LOG X display	1XXXXXXX	
	X LIN*	Set LIN X display	0XXXXXXX	
26	CURSOR△X	Set△X	000XXXX1	
	CURSOR△X	Reset△X	000XXXX0	
	WTG	Set spectrum weighting	000XXX1X	
	WTG	Reset spectrum weighting	000XXX0X	
	CURSOR UPPER	Place cursor on upper display	000XX1XX	
	CURSOR LOWER	Place cursor on lower display	000XX0XX	
	OPERATE (FUNCTION)	Return to operate from LIST	000X1XXX	
	LIST	Set display to List	000X0XXX	
	ACST WTG	Set acoustic weighting	0001XXXX	
	ACST WTG	Reset acoustic weighting	0000XXXX	
27	TRANSLATOR ON	Set Translator On	XXXXXXX1	
	TRANSLATOR ON	Reset translator	XXXXXXX0	
	Set Cursor Value	Place cursor at position specified	XXXXXX1X	
	CAL	Set calibration value specified	XXXXX1XX	
	Display Mode	Set display mode specified	XXXX1XXX	
28	(read only)	Input overload (OVERLOAD STATUS)	XXXXXXX1	
	(read only)	Output overload (CRT)	XXXXXX1X	
	(read only)	Average in process	XXXXX1XX	
29	(read only)	BCD value of number of (MSB)	XXXXXXXX	
30	(read only)	averages taken	XXXXXXXX	
31	(read only)		XXXXXXXX	
32	(read only)	(LSB)	XXXXXXXX	

*Power on Default.

3.5.9 Grids (Secondary Address 14)

When writing plotter programs it is necessary to know what the dimensions of the grids are.

The ratio of width to height of a single trace display is 1:1.25. Dual trace grids are contained in the space of the single trace and the space in between the two grids is of a size such that if the height of one dual trace were 1 unit, then the height of the single trace grid would be 2.25, therefore, the space between the two grids on a dual trace display will be 0.25 or one ninth of the height of a single trace display grid.

The height of the characters which will fit a particular grid when the programmer wishes to label the mnemonics on the grid is 2.311% of the single trace height. This is assuming a standard aspect ratio of 1.425:1 and spacing of 1/2 the character width between, and a character height 94% of the line space. The resultant is 52 characters can be drawn within the width of one grid.

LIN X — The width of the grid is divided into 10 equal parts, or 40 cells per division.

LOG X — Starting with X = 25 at the right hand side of the grid, the linear distance to each line will be: log (lin value) − log (25). The line values used will be: 25, 40, 80, 100, 200, 400, 800, 1k, 2k, 4k, 8k and 10k.

Octave X — 36 cells per division for the first ten divisions. This leaves 40 cells for the overall.

Time Mode X — Divide the grid into 10 equal parts.

LIN Y — 5 divisions.

LOG Y (dB or PSD) — 7 divisions

LOG Y (V or EU) — 7 divisions with no grid lines in the second and fourth divisions (i.e., 3-1/2 divisions).

Time Mode Y — 8 divisions in single trace, 4 divisions in dual trace.

Overall — In LIN X or LOG X (not Octave or Time Mode) 8 cells beyond the end of the grid.

Grid/Trace Format

Grids

4 Bytes per grid line:

Byte 1 = X value start of line.

Byte 2 = Y value start of line.

Byte 3 = X value end of line.

Byte 4 = Y value end of line.

Scale = 0 – 255 from the bottom of the grid(s) to the top. If in the dual trace mode this means the bottom of the bottom grid to the top of the top grid.

Trace

408 cells for spectrum — last 8 are overall.

511 cells for time mode.

Numerical data for the dimensions of trace are:

1 = bottom

241 = top

Log X Display

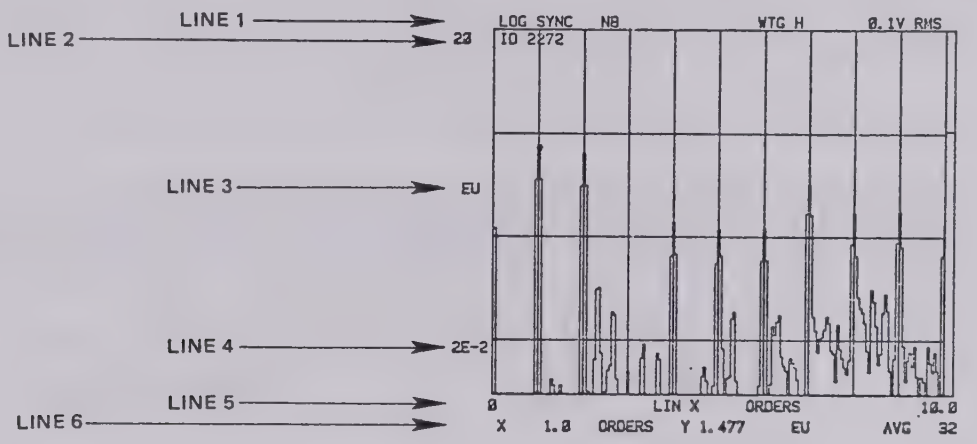
Because the SD345 deals with discrete information (400 cells) a Log X display must be achieved in discrete blocks of information. The method for accomplishing this is to table a set of FFT (Spectrum) data cells in the 400 linear cells of the crt. This results in an equivalence of FFT cells to display cells which is as close to Log X as the 400 increments can achieve.

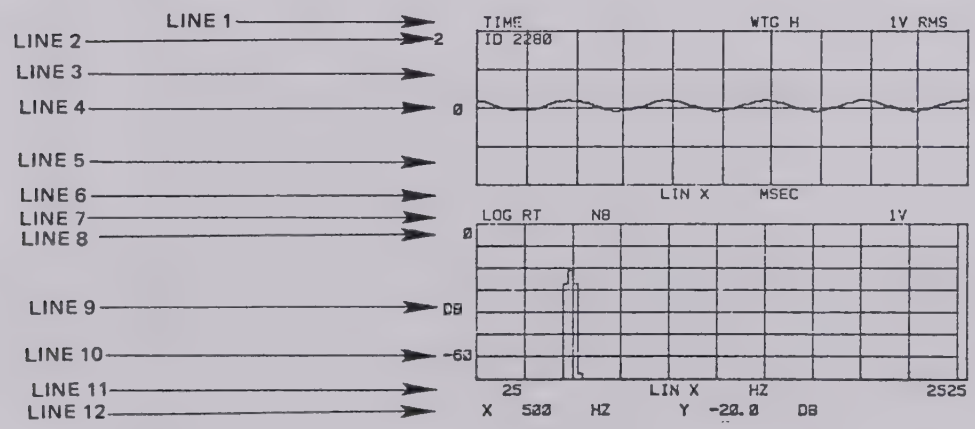
FFT Cell Numbers	Display Cell Numbers
1	1 — 45
2	46 — 72
3	73 — 92
4	93 — 106
5	107 — 119
6	120 — 129
7	130 — 138
8	139 — 146
9	147 — 153
10	154 — 159
11	160 — 165
12	166 — 170
13	171 — 175
14	176 — 180
15	181 — 184
16	185 — 188
17	189 — 192
18	193 — 196
19 — 25	197 — 213 in steps of 3
26 — 400	Any Log X conversion will do.

3.5.10 Annotation (Secondary Address 15)

Display Annotation

If it is desired to write additional information on a display, it will first be necessary to know where the line numbers are located on the display. The location of the lines and the number of lines is dependent on the selected display (i.e., single trace, dual trace, V, dB, etc.). The number of lines can be from 6 to 12. An example of the line number location is shown in the following illustration. In the time mode there are two lines which occasionally have no characters present. These lines can still be written on and are shown on the time trace on the dual display example in the following illustration.





Menu Annotation

Line number one is the Menu title. When a menu is displayed and annotation is input to the instrument, the annotation will appear on the screen with 10 spaces placed to the left of the line. When this same input annotation is outputted, it will be output with these 10 spaces appearing first.

Skip Code

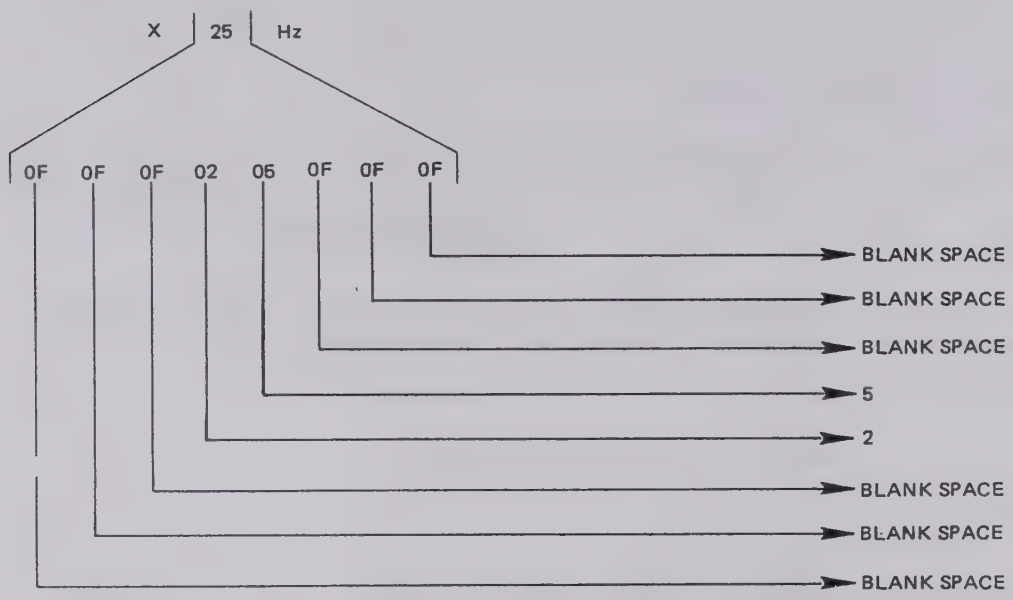
When inputting annotation on a line where characters are already present, and it is desired to write on this line without removing any of the characters, it will be necessary to write a skip code wherever the characters appear. The skip code for the SD345 I/O annotation is a binary 1.

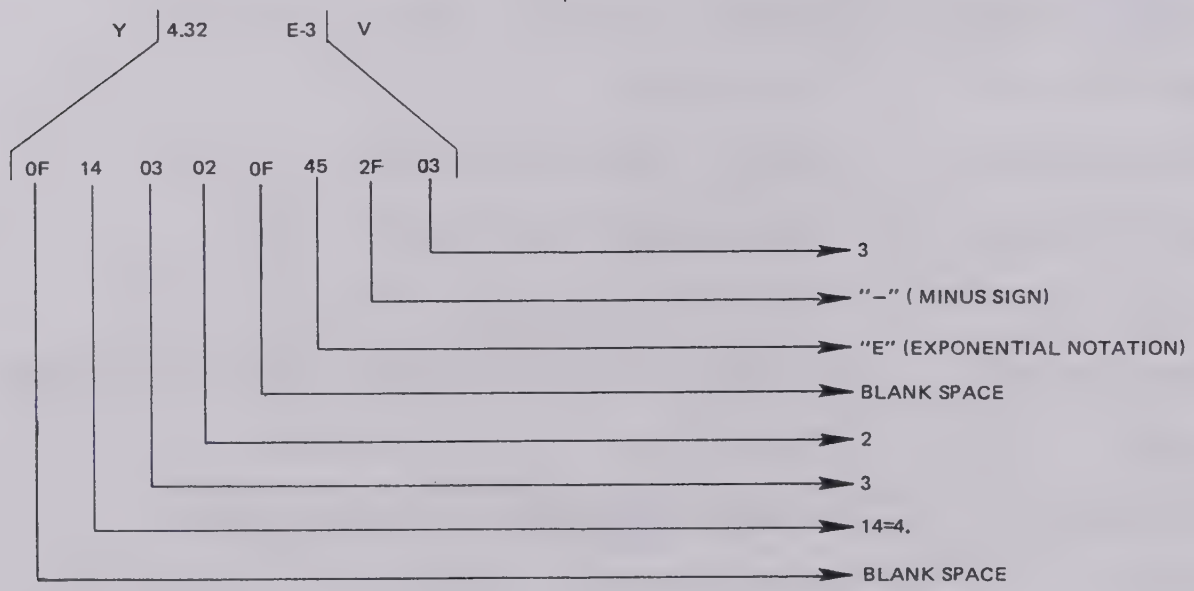
3.5.11 Calibration (Secondary Address 17)

This is a 60 byte string of data consisting of the following information:

Byte Number	Description of Data
Bytes 1 through 8 (Cursor information in SD345 "BCD" format.)	X Units: Hz, KCPM, ORDERS — 6 digits or 5 digits plus decimal. Translator — 8 digits or 7 digits plus decimal.
Bytes 9 through 16 (Cursor information in SD345 "BCD" format.)	Y Units: Volts, dB, EU, PSD.
Bytes 17 through 24	LIN X4 or Translate upper X-axis limit.
Bytes 25 through 28	Number of Averages actually taken for display (output).
Bytes 29 through 32	Cursor cell location.
Bytes 33 through 40	LIN X4 or Translate lower X-axis limit.
Bytes 41 through 44	Y full scale lower sweep (dual display).
Bytes 45 through 48	Y zero scale lower sweep (dual display).
Bytes 49 through 52	Y full scale upper sweep (dual display) or Y full scale single sweep.
Byte 53	Not used.
Bytes 54 and 55	1/3 Octave band number or 1/1 Octave band number.
Byte 56	Display status byte: X X X X X X 1 X — SD346 (Optional Signature Ratio Adapter in operation). X X X X X X X 1 — Overall is near full scale. X X X X X 1 X X — Output overload condition.
Bytes 57 through 60	Y zero scale upper sweep (dual display) or Y zero scale single sweep.

An example of the Calibration X and Y cursor readouts in the SD345 "BCD" format. (Refer to Table 3-5.)





3.6 UNDERSTANDING THE RS-232-C COMPUTER/TERMINAL INTERCONNECT

The RS-232-C cable is connected to J17 on the rear panel of the SD345. Table 3-8 is a complete pin assignment list for J17. The RS-232-C signals are indicated by an asterisk next to the pin number. The pin assignment numbers referred to in the following text refer to the pin numbers on the RS-232-C cable, not the pin numbers on J17.

There are six lines which govern data exchange in the RS-232-C pinout. These six lines are explained as follows:

Transmit Data — This is the line that the TERMINAL transmits data to the COMPUTER.

Received Data — This is the line that the TERMINAL receives its data on as it is transmitted from the COMPUTER.

Data Terminal Ready (DTR) — This is the message sent by the TERMINAL to the COMPUTER when the TERMINAL is ready to receive data.

Data Set Ready (DSR) — This is the message sent by the COMPUTER to the TERMINAL preceding the sending of data from the COMPUTER to the TERMINAL.

Request To Send (RTS) — This is the message sent by the TERMINAL preceding the sending of data from the TERMINAL to the COMPUTER.

Clear To Send (CTS) — This is the message sent by the COMPUTER to the TERMINAL when the COMPUTER is ready to receive data.

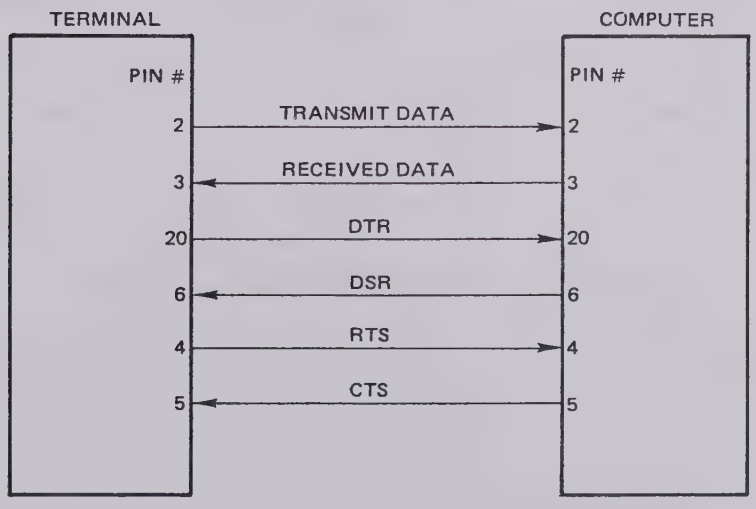


Figure 3-5. RS-232-C Computer/Terminal Interconnect.

Figure 3-5 shows message direction and pin assignments for the standard RS-232-C Computer/Terminal interconnect. Message sequence is as follows:

The TERMINAL sends data and control signals on pins 2, 4 and 20. The COMPUTER sends data and control signals on pins 3, 5 and 6.

The TERMINAL receives data and control signals on pins 3, 5 and 6. The COMPUTER receives data and control signals on pins 2, 4 and 20.

The RS-232-C pin assignment labels adequately describe the data exchange on a Computer/Terminal interconnect. The pin assignment labels become vague and even confusing when it is necessary for a Terminal/Terminal or Computer/Computer interconnect. The following information and illustrations are provided to aid the user when making a Terminal/Terminal or Computer/Computer interconnect.

Figures 3-6 and 3-7 show the proper Terminal/Terminal and Computer/Computer interconnect sequence. The adapters that are shown in these figures are included for the purpose of illustrating the cross-connect sequence and are not part of the I/O Option accessories.

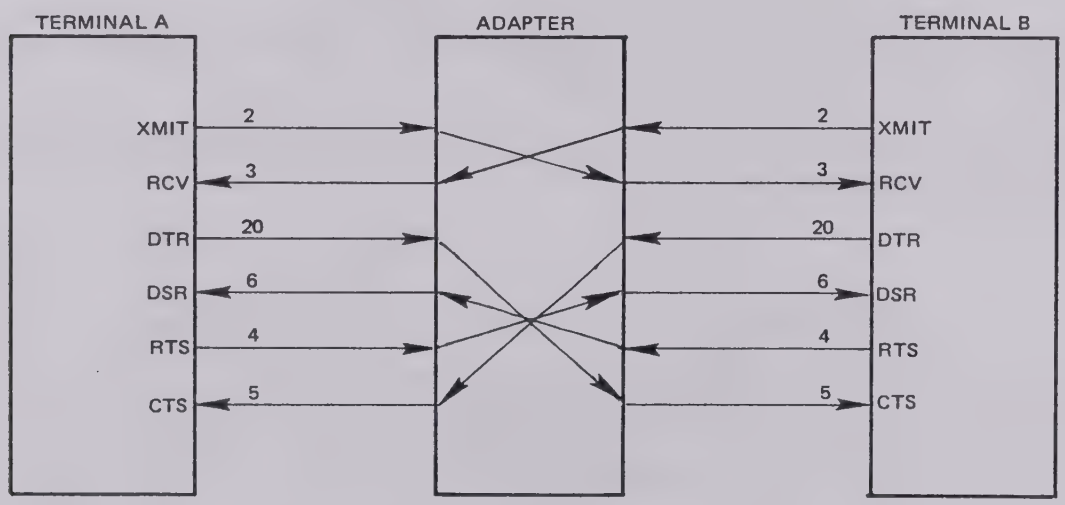


Figure 3-6. Terminal/Terminal Interconnect.

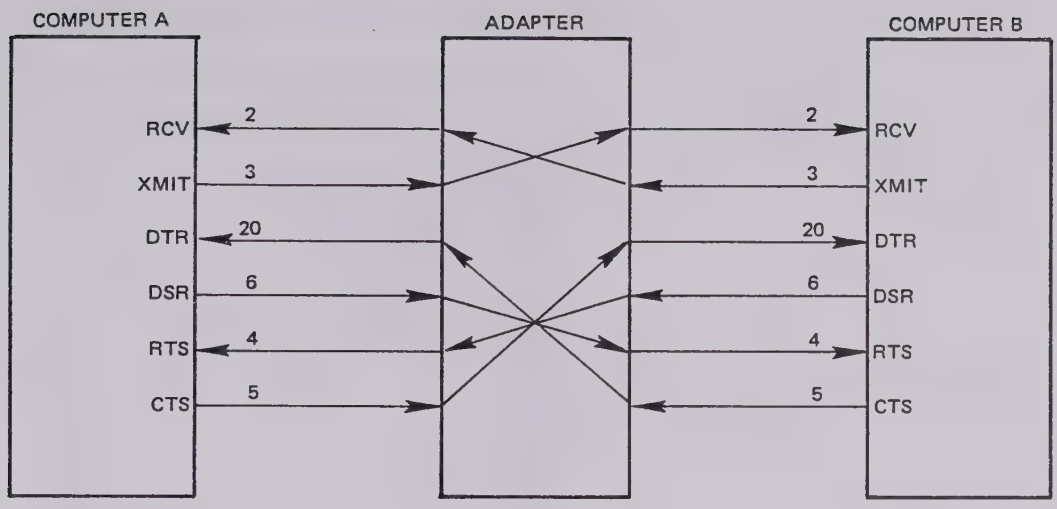


Figure 3-7. Computer/Computer Interconnect.

Table 3-8. Sense and Control Connector (J17) Pin Assignments

Pin	Assignment
1*	GROUND B
2	REMOTE PLOTTER RESET
3	REMOTE MEM HOLD
4	REMOTE AVG ERASE
5	REMOTE +1 AVG
6	REMOTE PLOTTER START
7	DIO5
8	DIO1
9	DIO3
10	DIO2
11	DIO4
12	DIO6
13	RETRACE BLANK
14	REMOTE MEM TRANS
15	END OF PLOTTER SWEEP OUT
16	REMOTE MEMORY UPDATE
17	SWEEP RATE FEEDBACK DISABLE
18	SPARE
19	SCOPE X
20	REMOTE AVG START
21	REMOTE BUFFERED
22	SELECT EXTERNAL SAMPLE
23	DC NORMAL/ACOUSTIC WEIGHT
24	SYNC
25*	CHASSIS GROUND
26	GROUND B
27*	DATA TERMINAL READY
28*	REQUEST TO SEND
29*	TRANSMITTED DATA
30*	RING INDICATOR
31	DIO7
32	SD346 OPERATE
33	DIO8
34*	RECEIVED LINE SIGNAL DETECTOR
35*	DATA SET READY
36*	CLEAR TO SEND
37*	RECEIVED DATA
38	TRANSFER COMPLETE BUFFER
39	LINE CURSOR
40	PLOTTER SWEEP OUT
*RS-232-C Signals.	

Table 3-8. Sense and Control Connector (J17) Pin Assignments (Continued)

Pin	Assignment
41	$\overline{\text{REMOTE TRANSIENT ARM/RELEASE}}$
42	SINE DITHER DISABLE
43*	OUT 1
44	SCOPE Y
45	DISPLAY REQUEST
46	MEMORY PERIOD
47	EXTERNAL TRANSIENT CAPTURE TRIGGER
48	EXTERNAL SAMPLE FREQUENCY
49	DISABLE F/P TRIGGER
50	SPARE
*RS-232-C Signals.	

3.6.1 RS-232-C Interconnect — The SD345's Implementation of the "Nonstandard Standard"

If the SD345's DSR is toggled true, the SD345 will stop and go to a listen state (i.e., it will stop sending data out of the port).

DTR will be set when the SD345 is ready to receive. If DTR is not set, the SD345 will not listen.

When the SD345 wants to talk, RTS will be set. However, if CTS is not true, the SD345 will not talk. If it is not possible to set CTS true when the SD345 sets RTS, it will be necessary to short RTS to CTS on the connector.

If "Break" is sent to the SD345 it will be received on the Received Data line and will be interpreted by the SD345 as a "framing error" and cause the SD345 to go to a listen state regardless of the SD345's prior status.

If it is desired to use the sense and control lines on J17 and interface RS-232-C with the SD345 at the same time, a Control Interconnect Assembly is available from Spectral Dynamics (Part No. 21254000). One end of this assembly connects to J17 on the rear panel of the SD345. On the other end of the cable is a box with three connectors labeled J1 (DCE), J2 (DTE), and J3. J1 is configured as a modem, J2 is configured as a terminal and J3 is a duplicate of J17. With this accessory, straight-through RS-232-C cables can then be used to connect an RS-232-C device to the SD345 and still have use of the other J17 signals.

3.7 IEEE MESSAGES AND DATA SEQUENCE

a. IFC should be first sent to put all devices on the bus in the idle state. In the idle state there are no talkers and no listeners. Therefore, no data can be sent and no data can be received.

b. In order for data transfer to occur, only one device can send data (talker) and one or more devices may receive data (listeners).

c. To set up a device as a talker, the following sequence of messages should be sent by the controller.

1. X10T T T T T (Talk address)

2. X11SSSSS (Optional secondary address)

T T T T T = 5 bit IEEE talk address

SSSSS = 5 bit IEEE secondary address

X = Don't care

The optional secondary address needs to be sent only when the device requires secondary addressing. The SD345 does require secondary addressing.

Addressing a device to talk automatically causes all other devices to leave the talk mode so that there is only one talking device on the bus at a time. The device should be given an untalk command after each talk. This is done by sending the untalk command:

1. X1011111

All commands sent by the controller such as talk addresses and secondary addresses must be sent with the ATN line asserted. The ATN line distinguishes commands sent by the controller from raw data being transferred between a talker and one or more listeners.

d. Before setting up one or more devices to listen, it is wise to command all devices to unlisten. This is done by sending the unlisten command:

1. X0111111

e. Now that the bus is free of listeners, the devices which are desired to listen may be commanded to do so by having the controller send the following message sequence:

1. X01LLLLL (listen address)

2. X11SSSSS (optional secondary address)

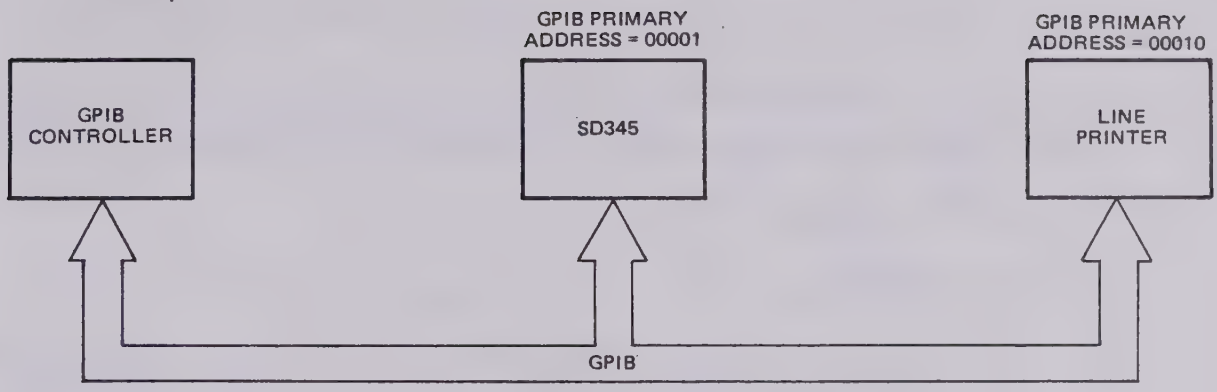
LLLLL = 5 bit GPIB listen address

SSSSS = 5 bit GPIB secondary address

X = Don't care

Again, the secondary address only needs to be sent if the device requires it.

f. Example:



The following example will show how to have the SD345 send annotation data to the line printer. Assume GPIB addresses as shown:

		DIO 8 7 6 5 4 3 2 1	ATN	IFC
Messages sent by Controller	1. Assert IFC	X X X X X X X X	X	1
	2. Send SD345 talk address	X 1 0 0 0 0 0 1	1	0
	3. Send SD345 secondary address for annotation = 15	X 1 1 0 1 1 1 1	1	0
	4. Send unlisten	X 0 1 1 1 1 1 1	1	0
	5. Send line printer listen address	X 0 1 0 0 0 1 0	1	0
	When ATN is unasserted the SD345 sends annotation data to the line printer.	D D D D D D D D D D D D D D D D	0 ↓ 0	0 ↓ 0

3.8 DIGITAL PLOTTER

Plotter (secondary address 3) is a special output of grids, annotation and trace in either HP-GL (Hewlett-Packard Graphics Language) or TEK 4662 Graphics Language. There is a series of HP graphics devices that are compatible with the SD345 I/O (refer to Table 1-1). The interconnects and setups (refer to Figures 3-8 to 3-11) for some of the HP graphics devices and the TEK 4662 are described in subsequent subsections.

HP-GL and TEK 4662 are ASCII, so Plotter cannot be binary. Echo and Quite apply only to data inputs. Plotter exits the port assigned to Trace (secondary address 16). Plotter is menu controlled and may be initiated from either remote or by depressing the front-panel PLOTTER group START touch control.

Things to know about DIGITAL PLOTTER:

a. Trace data must be in binary for Plotter to work. This is because the information is already in ASCII and the instrument will perform an ASCII conversion on the ASCII HP-GL instructions.

b. The cursor does not appear in the following:

   1. SET REF value of ΔX.

   2. LIN X4 (In dual trace LIN X4, the cursor will not appear if it is on the lower trace. If the cursor is on the upper trace it may appear at the right hand end of the lower trace.)

c. After starting a plot, the front-panel LOGO and ON/OFF switch should not be depressed.

d. If it is desired to stop in the middle of a plot, depress the PLOTTER group STOP touch control.

3.8.1 Digital Plotter Interconnect — HP7225A (RS-232-C)

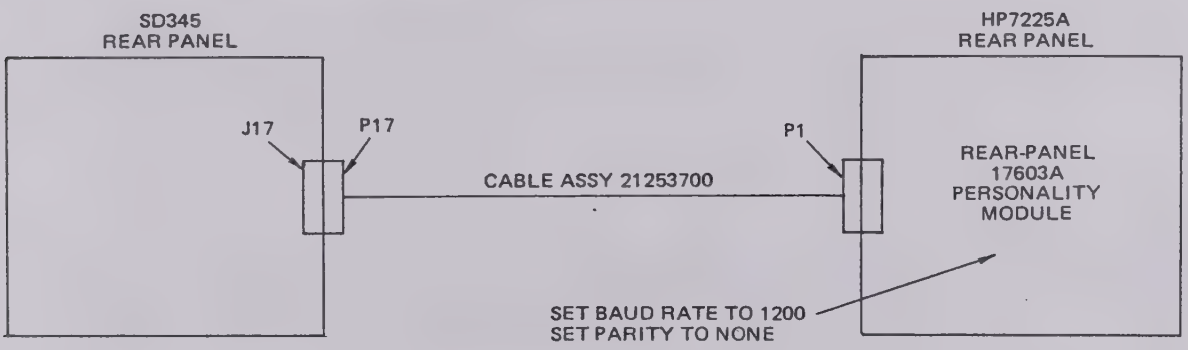


Figure 3-8. SD345/Digital Plotter Interconnect — HP7225A (RS-232-C).

SD345 Rear-Panel DIP Switch Settings

IEEE ADRS Switches 1→5 — Set to primary address 1 (00001)

ADRSABLE/TALK ONLY/LISTEN ONLY Switches 6 and 7 — Set to TALK ONLY

IEEE/RS-232 Switch 8 — Set to RS-232

AUX SW I/O FUNCT SET Switches 1→4 — Set to secondary address 3 (0011)

AUX SW Switches 5→8 — Set to the following configuration:

Setting:	1	X	1	1
Switch Number:	8	7	6	5

SD345 I/O Card DIP Switch Settings

DIP Switch U9

Switches 1→3 — Baud Rate
Set to 1200

Switches 4 and 5 — Parity
Set both switches to the zero position

Switch 6 — Stop Bit
Set to 2 stop bits

Switches 7 and 8 — Word Length
Set to 7 bits

DIP Switch U54

Switches 1→6 — Slew Rate
Set all to the zero position

Switch 7 — Not Used
Set to the one position

Switch 8 — CR CR/LF
Set to the CR/LF position

Switch 9 — SDC format, Customer Format/ Power on Default
Set to the Customer Format/Power on default position.

Switch 10 — Data Polarity
Set to the Positive True position.

NOTE

It will be necessary to disconnect the line connected to the *Plotter's* RTS signal, as this line toggles insanely during input of data and totally fouls up the operation of the RS-232-C portion of the I/O.

3.8.2 Digital Plotter Interconnect — HP7225A (IEEE)

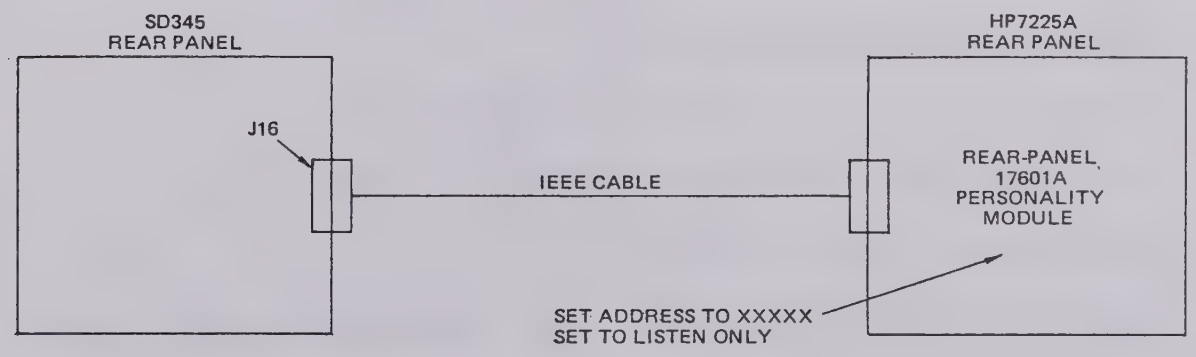


Figure 3-9. SD345/Digital Plotter Interconnect —HP7225A (IEEE).

SD345 Rear-Panel DIP Switch Settings

IEEE ADRS Switches 1→5 and ADRSABLE/TALK ONLY/LISTEN ONLY Switches 6 and 7 are set up the same as in RS-232.

IEEE/RS-232 Switch 8

Set to IEEE

AUX SW Switches 1→8 are set up the same as in RS-232.

SD345 I/O Card DIP Switch Settings

DIP Switch U9 is set up the same as in RS-232.

DIP Switch U54 is set up the same as in RS-232.

3.8.3 Digital Plotter Interconnect — HP7220A (RS-232-C)

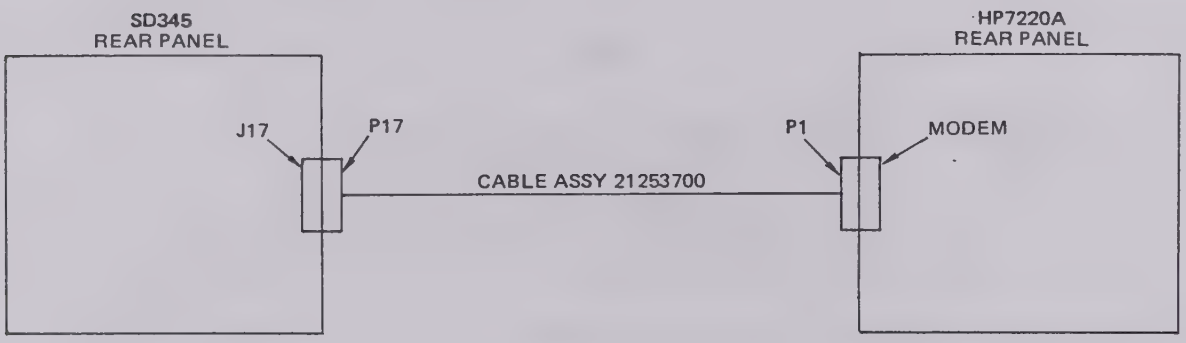


Figure 3-10. SD345/Digital Plotter Interconnect — HP7220A (RS-232-C).

SD345 Rear-Panel DIP Switch Settings

IEEE ADRS Switches 1→5 — Set to Primary address 1 (00001)

ADRSABLE/TALK ONLY/LISTEN ONLY Switches 6 and 7 — Set to TALK ONLY

IEEE/RS-232 Switch 8 — Set to RS-232

AUX SW I/O FUNCT SET Switches 1→4 — Set to secondary address 3 (0011)

AUX SW Switches 5→8 — Set to the following configuration:

Setting:	1	X	1	1
Switch Number:	8	7	6	5

SD345 I/O Card DIP Switch Settings

DIP Switch U9

Switches 1→3 — Baud Rate
Set to 1200

Switches 4 and 5 — Parity
Set both switches to the zero position

Switch 6 — Stop Bit
Set to 2 stop bits

Switches 7 and 8 — Word Length
Set to 7 bits

DIP Switch U54

Switches 1→6 — Slew Rate
Set all to the zero position

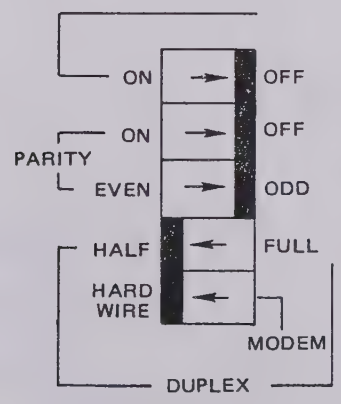
Switches 7→10 — Various
Set all to the one position

NOTE

It will be necessary to disconnect the line connected to the *Plotter's* RTS signal, as this line toggles insanely during input of data and totally fouls up the operation of the RS-232-C portion of the I/O.

HP7220A Settings — Rear Panel

Set the Baud Rate to 1200 and place the slide switches in the following configuration:



HP7220A Settings — Front Panel

Turn Plotter on, depress ON LINE, set P_1, P_2 for grid size, initiate plot.

3.8.4 Digital Plotter Interconnect — TEK 4662 (IEEE Only)

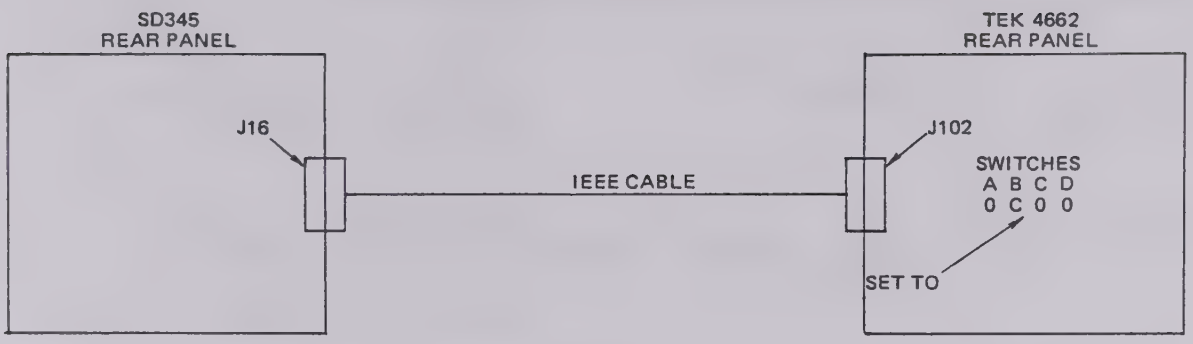


Figure 3-11. SD345/Digital Plotter Interconnect — TEK 4662 (IEEE Only).

SD345 Rear-Panel DIP Switch Settings

IEEE ADRS Switches 1—►5 — Set to primary address 1 (00001)

ADRSABLE/TALK ONLY/LISTEN ONLY Switches 6 and 7 — Set to TALK ONLY

IEEE/RS-232 Switch 8 — Set to IEEE

AUX SW I/O FUNCT SET Switches 1—►4 — Set to secondary address 3 (0011)

AUX SW Switches 5—►8 — Set to the following configuration:

Setting: 1 X 1 1

Switch Number: 8 7 6 5

SD345 I/O Card DIP Switch Settings

Dip Switch U9

Set to the following configuration:

Setting: 0 1 1 0 0 1 1 0

Switch Number: 1 2 3 4 5 6 7 8

DIP Switch U54

Set to the following configuration:

Setting: 0 0 0 0 0 0 1 1 1 1

Switch Number: 1 2 3 4 5 6 7 8 9 10

Use of the PLOTTER UPPER RIGHT/LOWER LEFT Controls

The setting of the UPPER RIGHT and LOWER LEFT controls on the TEK 4662 DIGITAL PLOTTER defines the dimensions of the entire page including annotation (refer to Figure 3-12). If it is desired to dimension the plot using graph paper, it will be necessary to determine the upper right and lower

left dimensions of the grid. This can be accomplished by depressing the SD345 PLOTTER Group CAL, 0,.01 and FS touch controls (CAL LED must be on) after the PLOTTER UPPER RIGHT/ LOWER LEFT settings have been made. In order to set the PLOTTER pen on the proper coordinates on a sheet of graph paper, first set the upper right and lower left points on the PLOTTER a bit beyond the desired points on the graph paper, and then depress the SD345 0,.01 (lower left) and FS (upper right) touch controls. This will show where the grid will be in relation to the annotation. The result may not be the exact coordinates desired, therefore it will be necessary to reset the PLOTTER UPPER RIGHT/LOWER LEFT controls, and then check the grid coordinates with the SD345 0,.01 and FS touch controls until the desired coordinates are obtained. When this is accomplished, depress the PLOTTER Group CAL touch control to turn the CAL LED off.

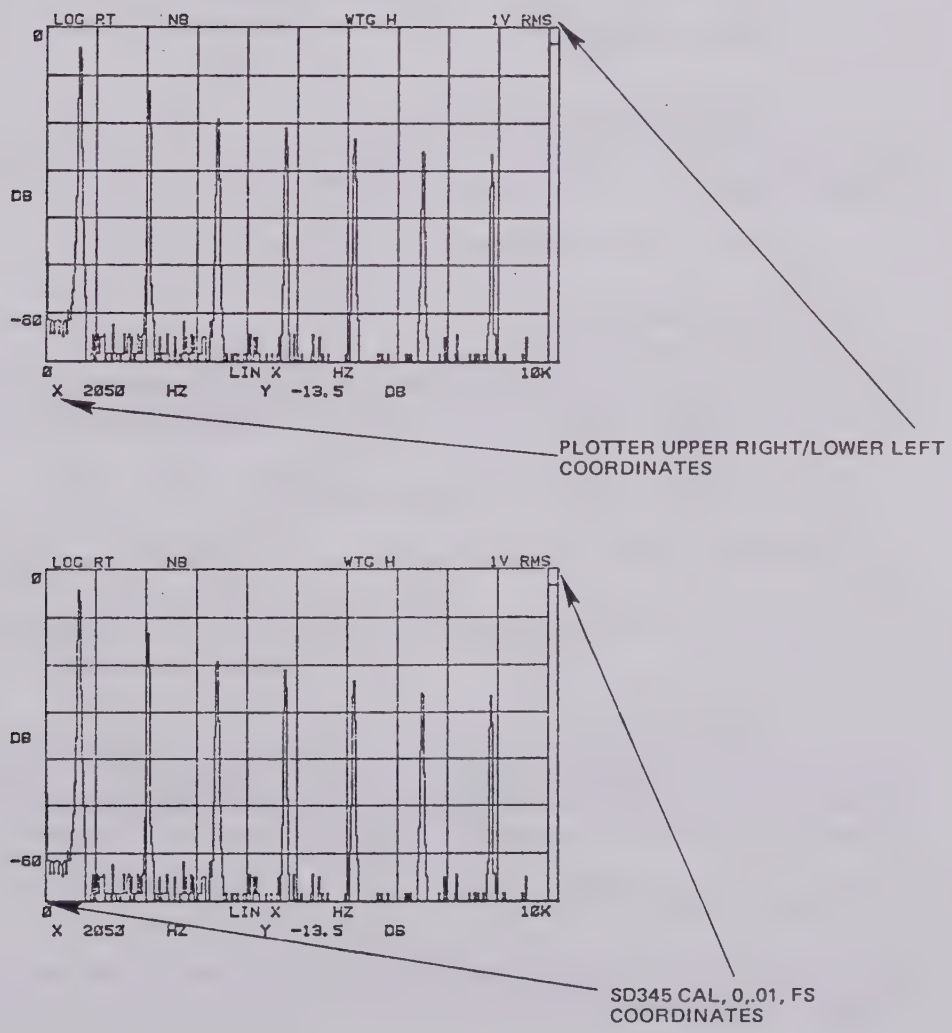


Figure 3-12. TEK 4662 Upper Right/Lower Left Locations.

3.9 ERROR MESSAGES

If an error is encountered during operation of the I/O Option, an error message will be generated and displayed on the crt. The error messages are numbered 2 through 8 and will appear as follows:

2 NOT ADDRESSED TO LISTEN

3 ADDRESS ERROR

4 REQUEST IN PROGRESS

*5 INVALID FUNCTION REQUEST

6 SD345 ERROR

7 REAR PANEL ERROR

8 RS-232 OVERRUN ERROR

The meaning of each error message is as follows:

2 — Data was sent when the SD345 was not addressed to listen.

3 — Invalid IEEE control bus.

4 — Valid secondary address was sent while instrument was processing another secondary address. This will happen only when RS-232 has control and is passing information out the IEEE port or vice-versa.

5 — Invalid secondary address or selected function.

6 — "Impossible" information from the I/O card or the IEEE chip is trying to talk to itself.

7 — Invalid primary address. For example: TALK ONLY and LISTEN ONLY set at the same time.

8 — Data sent too fast.

TIME mode data cannot be requested when the SD345 is in the SPECT mode and the I/O is in this configuration. To clear the I/O error message, depress the following touch controls on the front panel of the SD345: TIME, OPER (the instrument is in the LIST mode when displaying an error message).

3.10 SDC FORMAT

SDC format is the same as DEC floating point format except for data output sequence. The difference in data sequence is shown in Figure 3-13.

*An example of this error message would be as follows: The operator has selected, on the rear-panel DIP switches, IEEE, TALK ONLY and on the I/O FUNCT SET switches, secondary address 6 (Time Sets). Upon POWER-UP INITIALIZATION, I/O error message 5 will be displayed. The reason for this is that the SD345 always comes up in the SPECT mode during POWER-UP INITIALIZATION, and the operator has requested TIME mode data as an output.

SDC format consists of a 24-bit floating point fraction with sign and an 8-bit exponent. The high order bit (bit 7) of byte 1 is the sign of the fraction. The remaining bits of byte 1 and the high order bit of byte 2 (bit 7) comprise the exponent. The remaining bits of byte 2 (bits 6, 5, 4, 3, 2, 1 and 0) and the three high order bits of byte 3 (bits 7, 6 and 5) comprise the valid data from the SD345. (In both SDC and DEC format the MSB of the fraction is an assumed 1 and is not shown in Figure 3-13. The remaining bits (4, 3, 2, 1 and 0) of byte 3 and all of byte 4 are data zeros. These bits are beyond the SD345's accuracy but are sent to comply with the requirements of the format.

For purposes of reading the fractional data from the SD345, a representation of nominal full scale (0 dB) and the maximum fraction that can be read (+ 1.2 dB) are shown in Figure 3-13. The maximum fraction data value is equivalent to about 1.2 dB greater than the input level selected. The exponent data is arranged in excess 128 format using 0 dB as the 0 exponent.

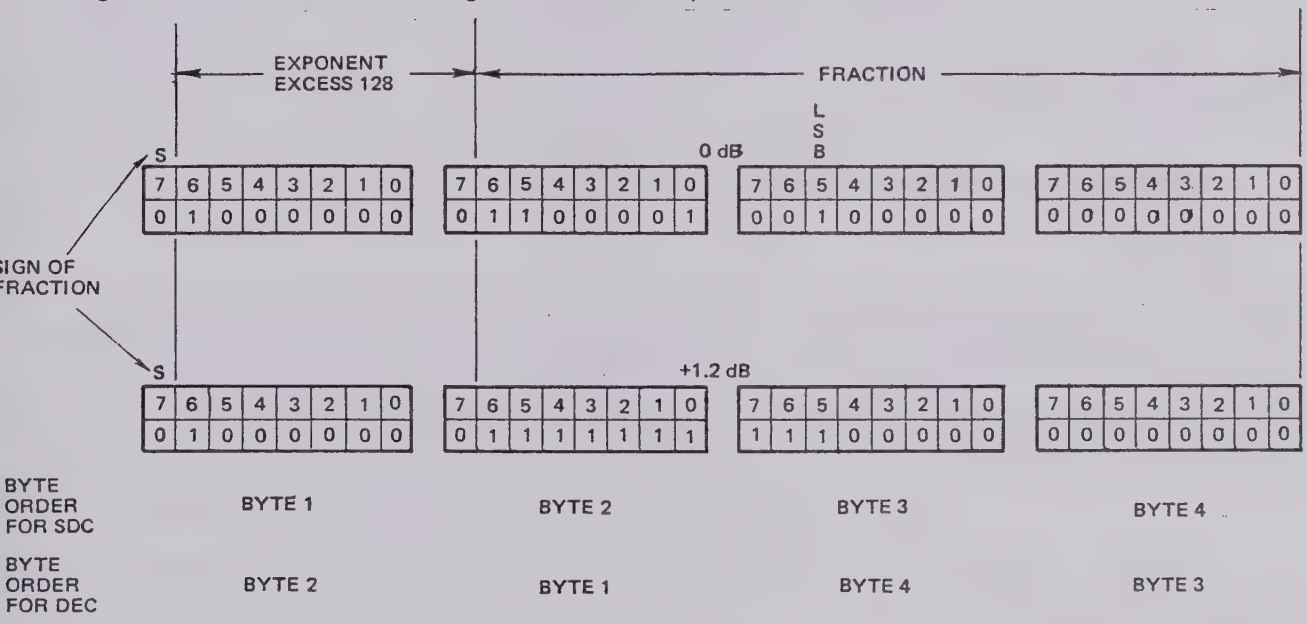
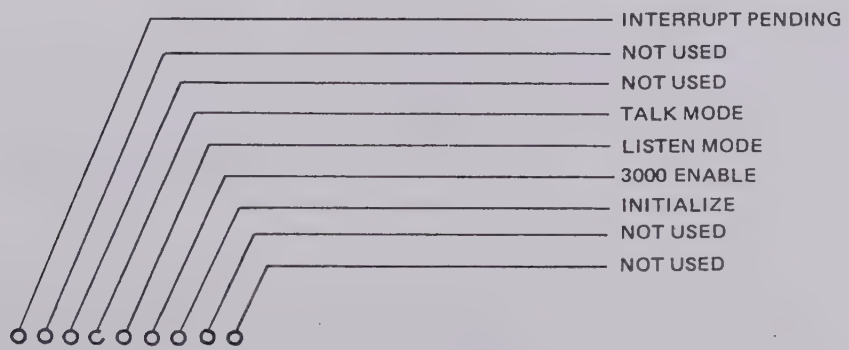


Figure 3-13. SDC Format.

3.11 I/O INTERFACE CARD STATUS LIGHTS

The Status Lights are nine LEDS located in the upper left-hand corner on the component side of the I/O Option circuit card. Only five of the nine are used. The Status Lights designate the operating status of the I/O Option. The definition of each status function is as follows:



INTERRUPT PENDING

Lights when either of the ports is busy (IEEE or RS-232-C).

TALK MODE

Lights when the instrument is configured to output data. LED will go out as soon as data transfer is complete. When the Addressable mode, may toggle with the LISTEN MODE LED. LED will stay on when the instrument is placed in the TALK ONLY mode.

LISTEN MODE

Lights when the instrument is configured to receive data. LED will go out as soon as data transfer is complete. When in the Addressable mode, may toggle with the TALK MODE LED. LED will stay on when the instrument is placed in the LISTEN ONLY mode.

3000 ENABLE

Lights when the 3000 Microprocessor has control of the I/O Option memory.

INITIALIZE

This LED should stay lit as long as the I/O Option circuit card is installed and the instrument is turned on. Indicates the instrument is aware that the I/O Option circuit card is present.

NOTE

This LED will go out when the power switch is in the OFF position. This does NOT mean the I/O card is no longer present.

SECTION IV

CONCEPT OF OPERATION

4.1 INTRODUCTION

Two Microprocessor systems (the 3000 and Z80) comprise the major controlling elements within the SD345 Spectrascope III. Figure 4-1 is a simplified Block Diagram showing the relationship between these two Microprocessors and the I/O Interface Option.

The 3000 Microprocessor, commonly referred to as the number cruncher, supervises the collecting, converting and processing of the analog input signal. Acting as an overseer, the Z80 Microprocessor interfaces with the outside world accepting information from and supplying data to front panel touch controls, crt and external devices (including the I/O Interface Option).

4.1.1 Communications

Communications between the two processors are achieved through a commonly accessible Random Access Memory with the meaningful title of the "Mailbox". Front and rear panel information is loaded into the Mailbox by the Z80 Microprocessor. The 3000 Microprocessor then accesses the Mailbox for the parameters it needs to perform its tasks. After completing its task of processing the analog signal into spectrum data, the 3000 Microprocessor loads the Mailbox with data that the Z80 Microprocessor needs to communicate with the outside world by annotating the crt, updating front panel status, and passing data to external devices.

4.1.2 Control

Note in Figure 4-1, that control between the two Microprocessors is implicit in the data that each loads into the Mailbox. Also in transferring front panel and rear panel status into the Mailbox, the Z80 Microprocessor has two sources of this data: The front and rear-panel switches, or through the I/O Interface from an external control device. The 3000 Microprocessor accepts the data through the Mailbox without regard to its source.

4.1.3 Data

Spectrum data is passed between the I/O Interface Card and the 3000 Microprocessor directly by the Z80 Microprocessor placing control data into the Mailbox instructing the 3000 to either accept spectrum data from or send spectrum data to the I/O Interface Option Card. Note that spectrum data is also sent directly from the 3000 Microprocessor to the crt while annotation data is supplied to the crt through the Mailbox and Z80 Microprocessor.

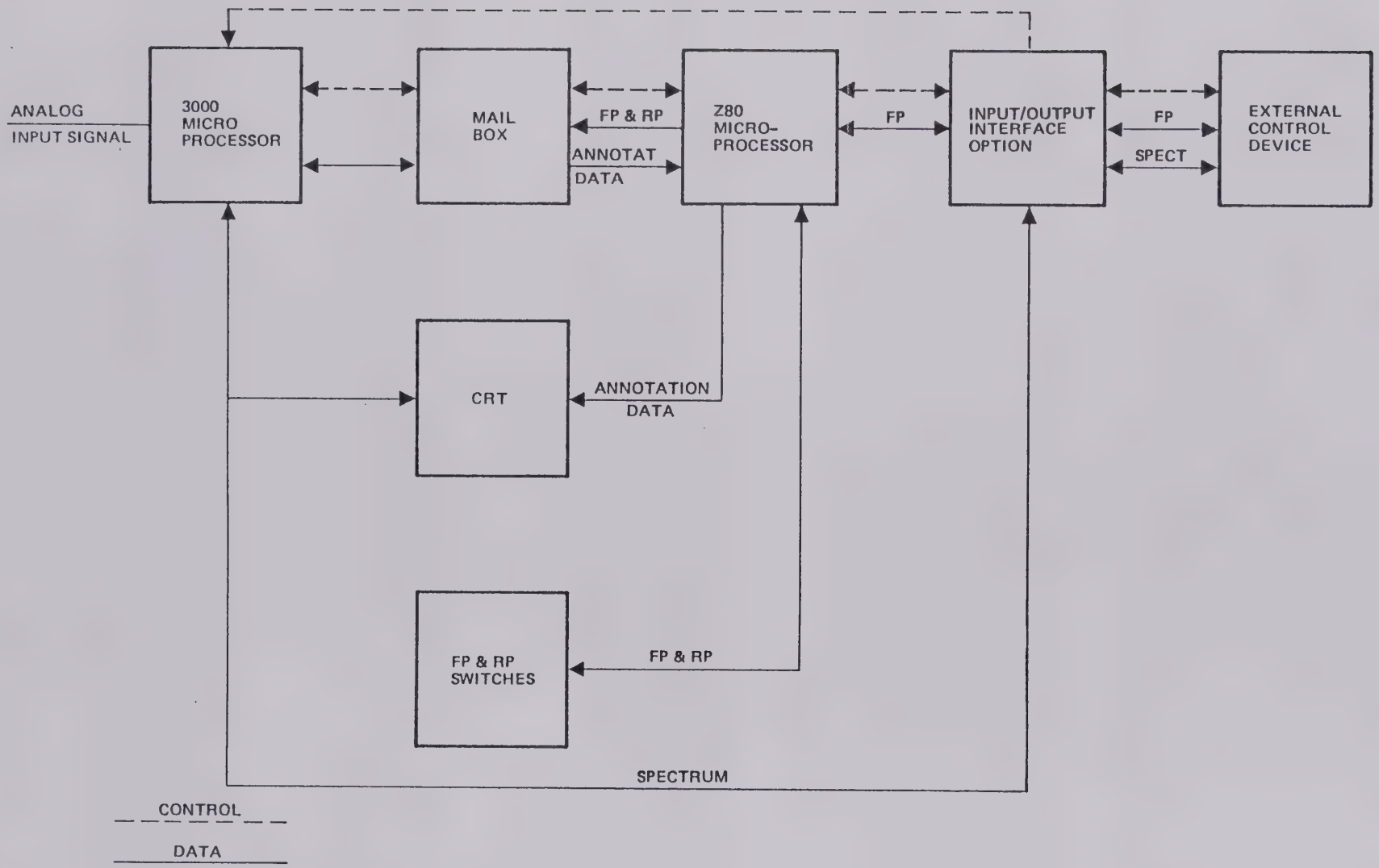


Figure 4-1. Microprocessor and I/O Interface Option Simplified Block Diagram.

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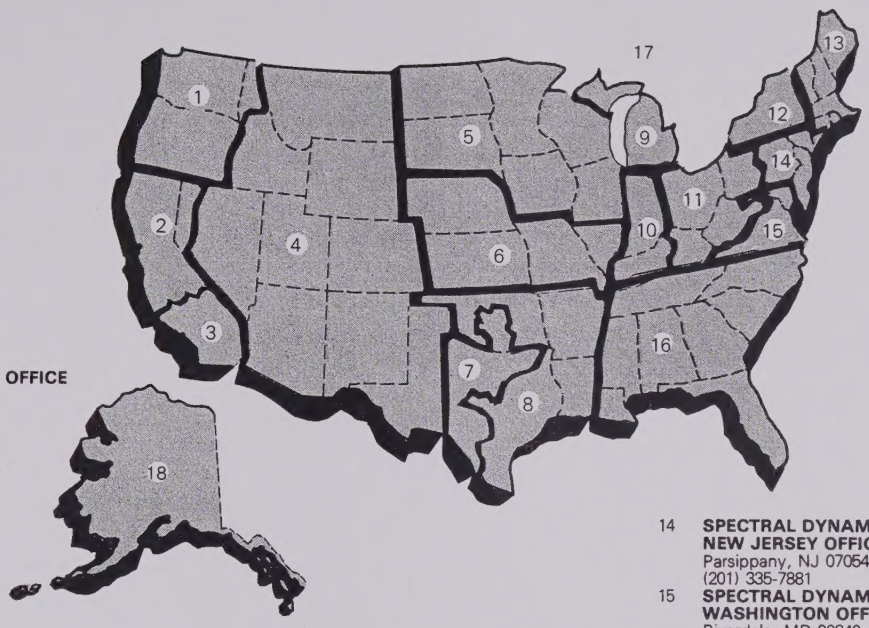

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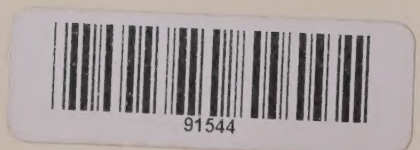
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